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The Engineer

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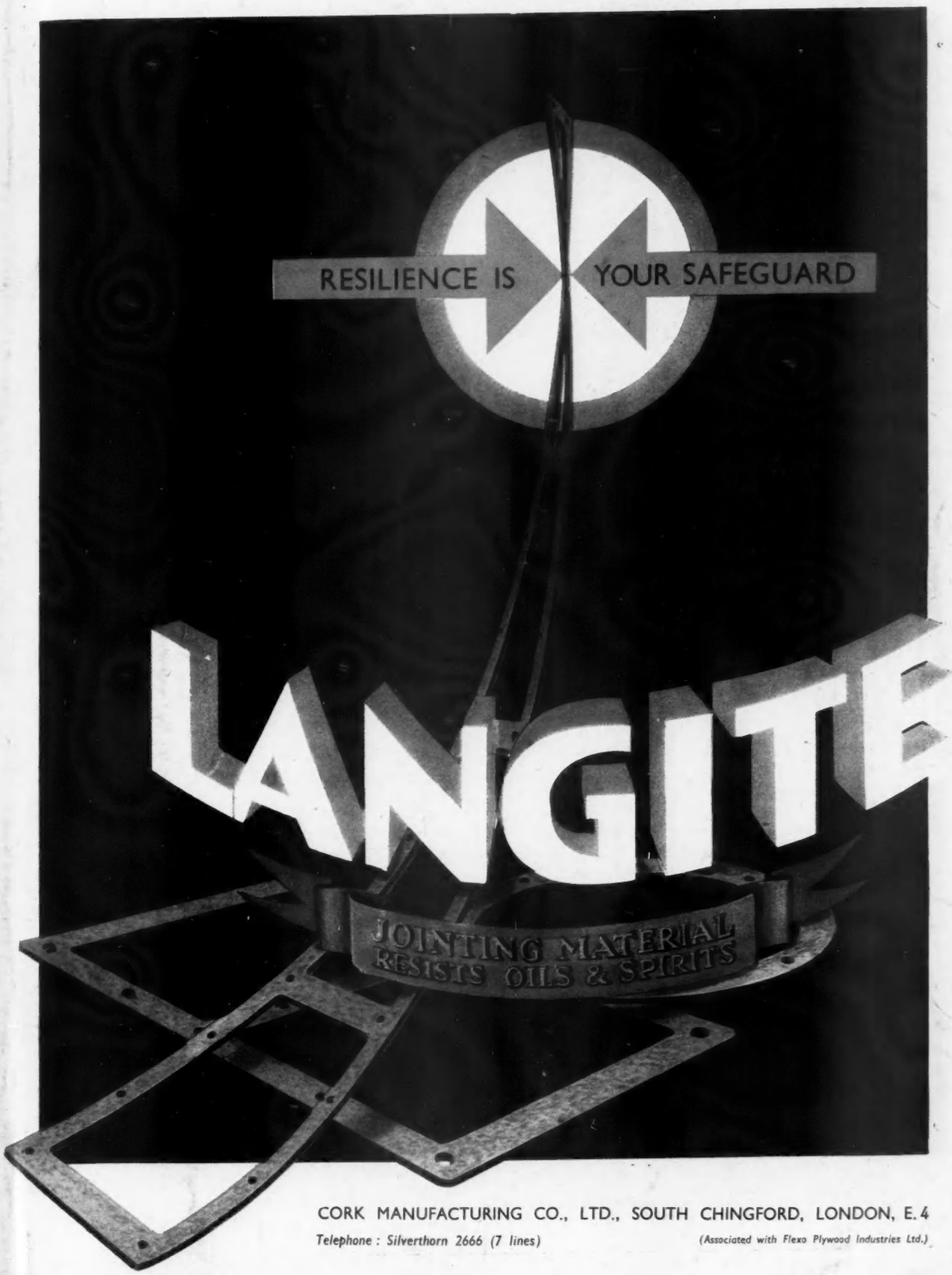

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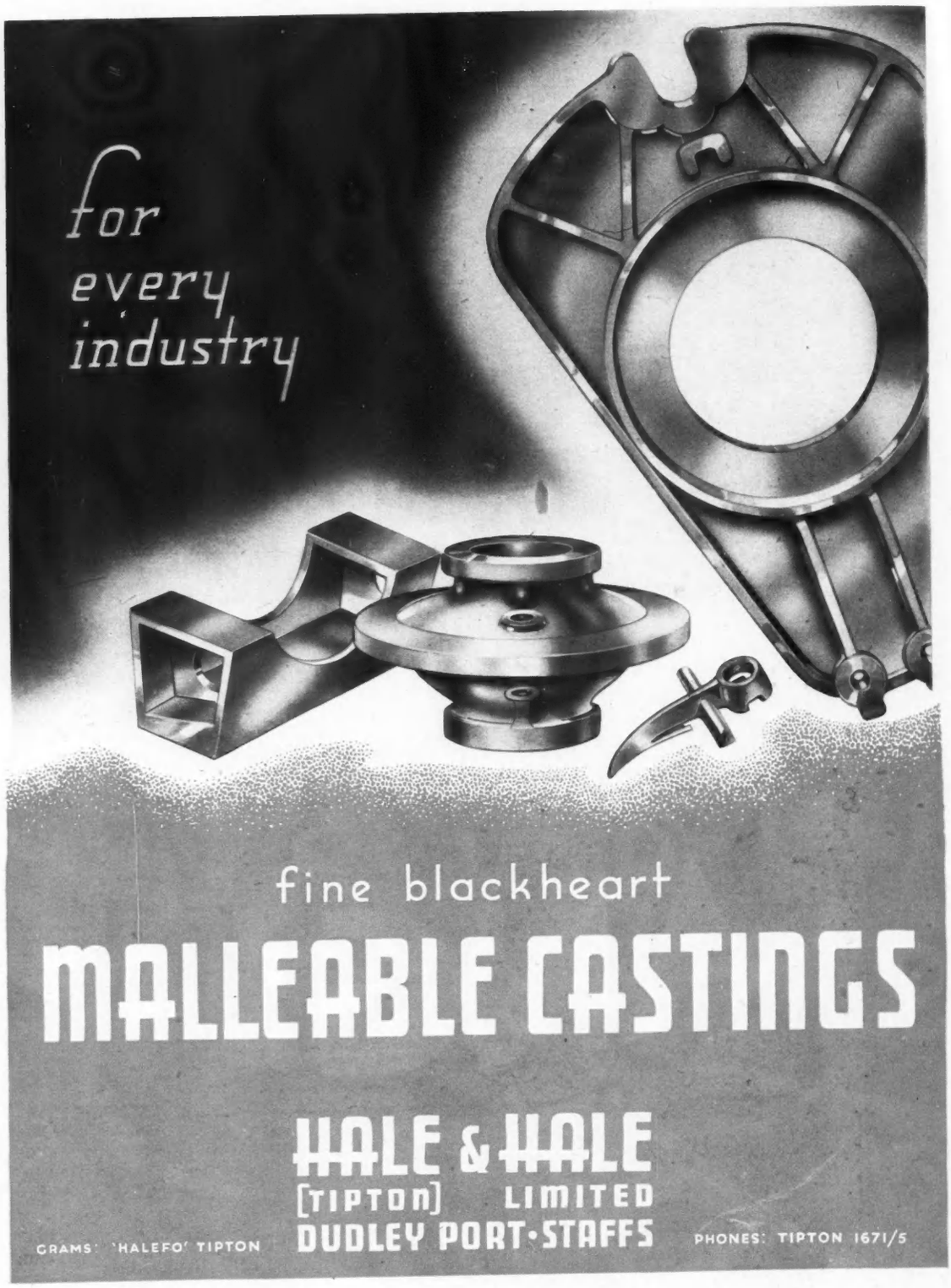
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The Engineer

LONDON, FRIDAY, NOVEMBER 19, 1943.

PUBLIC NOTICES

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Candidates should be over 30 years of age and hold a Degree in Mechanical Engineering or be Associate Members of the Institution of Mechanical Engineers and preferably have had experience in Organising Production in Workshops. Reference number C.1945A.

ENGINEER IN THE DEPARTMENT OF CONTROL OF HEAVY INDUSTRIES.

Candidates should be over 30 years of age and hold a University Degree in Civil Engineering or be Associate Members of the Institution of Civil Engineers.

They should have had General Engineering experience and be able to Advise on Projects submitted with a view to Allocation of Materials. Reference number E.804A.

Applicants should write to MINISTRY OF LABOUR AND NATIONAL SERVICE, CENTRAL (TECHNICAL AND SCIENTIFIC) REGISTER, ALEXANDRA HOUSE, KINGSWAY, LONDON, W.C.2, for the necessary application forms. The reference number of the post applied for must be quoted. 8577

The Directors of Thos. Firth and JOHN BROWN, Ltd., invite APPLICATIONS for the APPOINTMENT of PRINCIPAL of the Brown-Firth Research Laboratory, vacant by the death of Dr. W. H. Hatfield, F.R.S.

Applicants should preferably be of high academic standing, and wide experience in the metallurgy of Iron and Steel.

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IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

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1941 No. 2069
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WANTED, GENERAL MANAGER for Medium and Heavy Engineering and large Iron-foundry in Scotland; applicant must have highest qualifications, organising ability on latest production methods, and able to introduce payment by Results. Knowledge of latest Diesel, High-speed Engine and Compressor practice. Permanent and progressive post. State age, training and salary, &c.—Address, 8554, The Engineer Office. 8554 A

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The Engineer

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THE FACT that goods made of raw materials in short supply owing to war conditions are advertised in this paper should not be taken as an indication that they are necessarily available for export.

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Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of THE ENGINEER.

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Weapon Production in Scotland

THE Minister of Supply has been considering the rationalisation of certain weapon production at four munition works in the West of Scotland, three of which are managed for the Ministry by a private company and the other of which is privately owned by the same company. It has been decided that this production, which is not enough to give full employment to the four factories, should be concentrated in two of them, which will enable those two factories to run at about their present strength on munition orders. The Ministry of Supply has made arrangements for urgent work of a different kind and under different management to be taken up in part of one of the factories where weapon production is stopping. The Ministry of Production has been asked to consider whether there is any alternative use for that part of the other factory from which weapon production is being withdrawn. This is the factory referred to in the Thirteenth Report of the Select Committee on National Expenditure, dated October 28th, 1943, and the decision to close part of it is in accordance with the recommendations in that report.

The Blue Star Line, Ltd., and Aerial Transport

A FURTHER leading British shipowning company is to interest itself in aerial transport. In the Chancery Division of the High Court of Justice, on Monday, November 15th, Mr. Justice Bennett heard a petition presented on behalf of the Blue Star Line, Ltd., of St. Mary Axe, London, E.C.4, and confirmed an alteration to the objects of the company, which will enable it to carry on aerial transport. The petition was presented by Mr. J. F. Bowyer, who said that there was an affidavit by the chairman of the company, stating that it was engaged in the carrying on of an extensive shipping business with considerable success. Its directors were convinced that as soon as the war came to an end and the present war industries could be turned into peacetime activities, the aeroplane and aerial transport of all kinds would play an increasingly important part, not only in the affairs of the nation, but of the whole world. They were of the opinion that shipping companies, if they were to hold their own, must be prepared to carry on air transport business of all kinds in all parts of the world. The directors were, moreover, satisfied that the company would be able efficiently to carry on air transport business in conjunction with its existing shipping business. It was not the intention of the company, it was stated, to embark on air transport as a separate business. After hearing the petition, Mr. Justice Bennett decided that the memorandum of the company must be altered so as to make that clear. Subject to that condition he was willing to confirm the alteration of the company's objects.

Mr. Fred Cooper's Appointment

ON Monday, November 15th, it was officially announced that Mr. Fred Cooper, the well-known naval architect, who has designed a number of famous high-speed motor-boats, has joined the staff of Rotol, Ltd. It may be also noted that Rotol Airscrews, Ltd., has now altered its name to Rotol, Ltd., in accordance with the wider field of activities in connection with the supply of aircraft accessories which it is now covering. After the last war Mr. Cooper joined the firm of S. E. Saunders, Ltd., of East Cowes, where he was responsible for the design of the famous 1½-litre international class racing boat "Newg" for Miss M. B. Carstairs, with which she won the Duke of York's International Trophy, and also the world's speed record for that class of motor-boat. Subsequently Mr. Cooper was appointed the manager of the British Power Boat Company, Ltd., where he designed the late Sir Henry Seagrave's "Miss England I," which at that time was the fastest single-engined boat in the world. In 1929 that boat was the winner of the World's Water Championship, which was run at Florida. Later in the same year Mr. Cooper began practice on his own account as a consulting naval architect, and during the following ten years he was the designer of many other successful craft. They included the late Sir Henry Seagrave's "Miss England II," which, we may recall, secured the world's unlimited water record for Great Britain on no less than three separate occasions. Mr. Cooper was also the designer of Sir Malcolm Campbell's racing motor-boat "Blue Bird," which in 1938 gained the world's water speed record. During the war period Mr. Cooper has been engaged on special designs of motor craft for the Admiralty.

The Late Sir William Noble

SIR WILLIAM NOBLE, a director of the General Electric Company, Ltd., died in London on November 9th, at the age of eighty-two. Sir William was a native of Aberdeen and began work in the Post Office Telegraph Department of that town in 1874. At the age of thirty-two he was made Post Office engineer for North-East Scotland. He was subsequently transferred to London and earned rapid promotion to various appointments until he became Engineer-in-Chief of the G.P.O. He was one of this country's leading experts in telephony and gave a great deal of time to research and development in this subject, both at home and abroad. He accompanied a number of missions to Europe, headed a Commission on the subject of automatic telephones to the U.S.A., and for his help to the Belgian telegraph and telephone engineers in the last war he was made Chevalier de la Croix Belgique. For his long and distinguished services he was awarded a knighthood in 1920. In 1922 he resigned from the Post Office. On his retirement he joined the board of the General Electric Company, Ltd., where he gave his attention and the benefit of his great knowledge and experience to the company's telephone works. He also continued to find outlets for his energy and talents in other directions. He was closely associated with the formation of the British Broadcasting Company, and was, in fact, one of its first directors. He has also served on the Executive Council of the Association of Chambers of Commerce and was for three years President of the Coventry Chamber of Commerce.

Brazil and Great Britain

IN an address to the Anglo-Brazilian Society, at a luncheon held at the Dorchester Hotel on Monday, November 15th, Mr. Oliver Lyttelton, the Minister of Production, referred to the good will which had passed to and fro between Brazil and Great Britain for more than one hundred years, and had again been strikingly evidenced when in 1942 Brazil first of all broke off all relations with the enemy Powers and later declared war against the German and Italian aggressors and brought all her resources to the side of the Allied Nations in their struggle for those causes which Brazil held dear. The vast resources which had been placed so unreservedly at our command, he said, were making a most important contribution to the defeat of the enemy. The Brazilian Navy and Air Force were helping us effectively and actively in the Battle of the Atlantic, while the patrolling of the Southern Atlantic by Brazilian naval forces had sent a number of U boats to their last account. At the present time we were bringing into this country from Brazil important quantities of foodstuffs, and of hides, and of quartz crystals and mica. We had helped all we could and had presented to the Brazilian Government outright the rights over the great iron ore deposits which were once the property of private British interests. When peace came, Mr. Lyttelton said, he hoped that we should not only resume, but improve, our pre-war records in commercial exchanges with Brazil. We did not forget that Brazil had an area greater than the United States and was richly endowed with fertile soil, raw materials, and large resources of hydro-electric power, and that iron and steel production and the manufacture of aluminium, cement, and cotton goods had been greatly expanded. That did not mean, he said, that the need for exports from this country would be less, but it meant that Britain would have to change the nature of her trade and supply Brazil with all the new products which the ingenuity and knowledge of our people had brought into the range of production during the war.

Protection of British Oil Tankers

THE Ministry of War Transport has recently issued some particulars of a compressed air device, which has been fitted to a number of British oil tankers and has been so effective that already a number of tankers have been safely brought to port with most of their cargoes intact after receiving torpedo damage which at one time would have proved fatal. This new device was evolved by Mr. William Lynn Nelson, the marine superintendent of the Eagle Oil and Shipping Company. It consists essentially of an air line fitted along the tanker, which is served by two air compressor units one at either end of the ship. Air pipe connections are made to all tanks. Should the vessel receive torpedo damage, the air compressors are started up and compressed air is forced into the damaged compartments. Pressure can be maintained until the tanker reaches port and repairs can be effected. The compressed air supply can also be utilised to work fire pumps when the supply of steam is cut off by damage to the engines. In the case of one large tanker which was torpedoed in the Mid-Atlantic, compressed air was used to work the steering gear, and the ship was brought into port after a twelve-day voyage. An additional use of the air supply was to bring oil to the galley oil-fired boiler so that hot meals could be cooked and served. Since the Ministry of War Transport adopted the system in 1942 scores of oil tankers have been equipped with this new and simple device.

Accident Prevention in Factories

AN interesting conference on the prevention of accidents in factories took place in Birmingham on Tuesday, November 16th, which was attended by a large number of industrialists. The chairman was Sir Miles Thomas, Vice-Chairman of the Nuffield Organisation. In welcoming the large number of business executives, Sir Miles referred to the abnormally high rate of accidents in industry, which in a period of twelve months had risen to over 300,000. That was a matter, he said, which was causing considerable concern in Government and industrial circles. The worker, male or female, was the most valuable constituent of our industrial system. It was the first charge on factory management to sustain and protect those workers, to promote their wellbeing, and to keep them safe. Only a safe factory could be an efficient factory. Sir Wilfred Garrett, H.M. Chief Inspector of Factories, said that it required training and experience to know where accidents happened, but the problem could be reduced almost to an exact science. He advocated trained accident prevention officers, safety committees, and training courses. Mr. Walter Higgs, governing director of Higgs Motors, Ltd., said that in an average engineering concern from 50 to 75 per cent. of the employees were injured annually. More thought, he suggested, should be given to the designing of machines and their method of operation, the relief of fatigue, improvements of lighting and heating, and the keeping of floors clean and free from obstructions. Dr. J. M. Davidson, H.M. Inspector of Factories in Birmingham, dealt with the chemical hazards of industry. He mentioned the many types of substances which were liable to cause poisoning in industry and suggested closer study of workers' interests by managements and the provision of perfect ventilation. Mr. A. P. Young, the manager of the B.T.H. Rugby works, stressed the importance of education, not only of the designers of machines, but also of the individual.

SALVAGE OF THE U.S.S. "LAFAYETTE"

Salvage of U.S.S. "Lafayette"

No. I

AFTER fully eighteen months on the bottom of her slip, at Pier 88 on New York City's North River waterfront, the U.S.S. "Lafayette"—the former French luxury liner "Normandie"—is again upright and afloat. In THE ENGINEER of August 14th, 1942, we described the circumstances in which, on February 9th, 1942, the ship sank and capsized because of the tons of water played on to and into her superstructure to put out a fire fanned by a strong north-west wind. The "Normandie" was rated as a vessel of 79,280 gross tonnage and of approximately 56,000 tons displacement. At the time she sank she was in process of being converted for wartime service, and the article just referred to was based upon a report made public by the United States Navy Department, under which her outfitting as a troop transport was being done.

The question has repeatedly been asked: "Why was the 'Lafayette' not scuttled at the time of the fire so that she would settle to the river bed and remain upright instead of capsizing?" The responsible agencies strove as best they could to get water into the lower compartments of the ship and so send her to the bottom before she could capsize by the accumulation of water in the superstructure from the fire-fighting boats and land pumpers, but their efforts were without avail. Curiously, the "Normandie" was built without any Kingston valves, and the only large openings in her bottom were for the condenser intakes. A gang was sent down into the engine-room to open the condensers so that water admitted to them would discharge into the ship; but a down draught blew so much smoke from the fire into the bowels of the vessel that those men were forced to leave their job before they had much more than started it. Any other openings higher up in the liner that might have served the purpose of delivering water into her bottom compartments were not known to the people aboard of her or in charge of her when the catastrophe occurred.

For some weeks after that catastrophe the Navy Department deliberated whether or not the ex-liner should be scrapped or an attempt should be made to raise her. The "Normandie," according to published statements, had cost her owners, the Compagnie Générale Transatlantique, when first placed in service in 1935, something like 56,000,000 dollars, and subsequent ameliorations increased that total substantially. In any case, even if a goodly number of millions of dollars should have to be spent in salvaging and reconditioning the ex-liner for military service, the U.S. Government would be well repaid by thus acquiring a ship of such size and high speed. The Navy Department, as a matter of sound public policy, submitted the question of what to do with the wreck to a special committee of eminent experts, both civilian and naval, and that body finally recommended that the vessel should be raised, but did not specify how the work should be done. The Navy Department then ordered Commander W. A. Sullivan, U.S.N., at the time Supervisor of Salvage of the Navy Salvage Service, to proceed with the reclamation of the U.S.S. "Lafayette." Under that specialist's direction an exhaustive study was made of the problem involved, and plans were developed for dealing with the sunken craft so that she might be righted and refloated by means of controlled pumping. Once settled upon, the work has been carried forward, night and day, since last year. In the first half of the current year, however, Commander Sullivan, who had been promoted to the rank of Captain, was ordered to North Africa to supervise extensive salvage operations that had to be conducted as the aftermath of the successful Allied African campaign; and because of his efficient work on the "Lafayette" and in Africa he was recently promoted to the rank of Commodore.

Prior to the present conflict, the office of Supervisor of Salvage was established in the Navy Department under the Chief of Bureau of Ships. The duties of the Supervisor of Salvage were to operate and to direct the salvage facilities and personnel secured by the Government under General Contract NOBs-36 with the Ships Salvage Division of the Merritt-Chapman and Scott Corporation, which had collaborated with the Navy Department during World War I. Under the foregoing recent contract all the facilities, including vessels, equipment, and personnel of what is said to be the largest marine salvage concern in existence, have been operated by the Supervisor of Salvage, U.S.N. Work on the "Lafayette," notwithstanding its exceptional magnitude, has been but just one of a great number of salvage operations conducted by the Navy Salvage Service, in combination with the Merritt-Chapman and Scott Corporation, during 1942–43, under the direction of the Supervisor of Salvage. In the case of the "Lafayette," because of the size of the job and the great responsibility involved, it was deemed inadvisable to place the burden directly upon the Ships Salvage Division of the private corporation mentioned, as had been the usual practice of the Navy Salvage Service in other kindred tasks. The salvage

of the "Lafayette" was therefore undertaken by the Navy, using as little of the key personnel of Merritt-Chapman and Scott Corporation as possible because of the already intensively occupied members of that organisation. The latter concern has been, and still is, hard at work on important and widespread salvage jobs in the coastal waters of the United States, the consequence of marine and war casualties.

Contrary to a belief widely held, no specific overall contract was let for the salvage of the "Lafayette." The Navy has placed certain of the key members of Merritt-Chapman and Scott on this undertaking, and additional personnel, equipment, and facilities have been obtained by sub-contract or otherwise in accordance with the terms and provisions of the general salvage contract (NOBs-36), to which reference has already been made. At the time work was started it was estimated that the salvage of the "Lafayette" could be completed in from one and a half to two years, the estimated cost ranging from 5 million to 6 million dollars. The contemplated outlays afforded a liberal margin, as will be noted later on.

Condition of Ship Before Salvage

The craft has an overall length of 1028ft. a beam of 119·5ft., and at her load draught she draws 38ft. The slip between piers 88 and 90 is 400ft. wide, and the piers themselves have a length of 1100ft. To obtain a sufficient depth of water for such large craft, it was necessary to excavate to a depth of 46ft. below mean low water a ledge of bedrock that slopes from the ground level at the bulkhead line riverward and reaches a depth of 160ft. at the outer end of the flanking piers. The excavated area has a mean length along the axis of the slip of about 365ft. The outer edge of the excavated rock shelf that crosses the slip has played a considerable part in the problem with which the salvors have been confronted. Since piers 88 and 90 were finished—about the time the ss. "Normandie" first entered the Port of New York in June of 1935—silt accumulated on the rock shelf to a depth of 10ft., and the water bed from the rock ledge outward to the river end of the slip is made up basically of strata of gravel and sand over which have been deposited successive layers of mud of different densities and thickness, the upper strata partaking more and more of the nature of semi-fluid silt and having but little sustaining capacity for a load laid on them.

When the "Lafayette" foundered and capsized she came to rest lying diagonally in the slip, the aftermost end of her keel crushing through some of the piles at the river end of the north side of pier 88, and the bow of the ship projected about 75ft. on the north side of the centre line of the slip, her forebody, about 250ft. abaft her stem, resting on the edge of the excavated rock shelf, which became a pivotal point of support, with about two-thirds of the length of the ex-liner extending westward and sustained by the soft mud or silt, as shown by the attached diagram, Fig. 1. During the three months immediately following her sinking, the ship settled 3ft. more by the stern, while her bow was lifted 1ft. The position of the vessel was steadied as soon as possible by lightening operations, and since then the ship had lain virtually unchanged in her posture—that is, her centre line plane being trimmed about 8ft. by the stern. So stabilised, the ship rested with the water surface of the slip cutting along her bottom on the starboard side of the keel strake and at the promenade deck to port of the normal centre line of that level of the superstructure. The wreck inclined at an angle slightly less than 80 deg. from the vertical. Substantially all openings in the promenade deck to port of the craft's centre line were submerged. Likewise, the air ports, cargo ports, and other openings in the port side of the ship were under water, the air ports, on an average, being submerged 60ft. below the surface of the river and buried in the mud to a depth of from 8ft. to 10ft. Some of the ports were open when the "Lafayette" went down, and others were smashed when she rolled over. All told, 356 of the immersed air ports had to be closed with patches that were braced and reinforced with concrete to make them able to withstand the hydrostatic pressure that would be developed when the water within the flooded craft was pumped out of her. In addition to the air ports that have required sealing, it was discovered that there were sixteen cargo ports on the submerged side of the ship that had to be closed before unwatering could begin. Those large ports had to be closed and then backed with reinforced concrete and shored before pumping could be started. In the way of open cargo

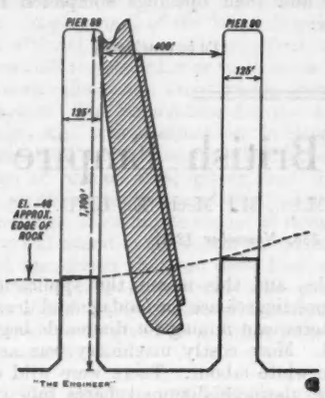


FIG. 1—POSITION OF "LAFAYETTE" BEFORE SALVAGE

ports the intrusive mud ranged from 10ft. to 12ft. deep, and in several instances, where both doors of a cargo port were open, more than 30ft. of mud had been squeezed inward through those portals. As the divers had to enter state rooms and other compartments to close the various openings, they had at times to work their ways to their goals through mud that overtopped them.

Work of Divers

The divers engaged in the foregoing work had to contend with great difficulties and to face many hazards. The complex internal structure of the "Lafayette" intensified the odds against those underwater toilers, who often had to find their way through devious and overturned narrow passages to reach state rooms, machinery spaces, and other subdivisions of the vessel, and then to reverse their courses in order to get safely out of that steel labyrinth and back to the surface. It was impossible to give the divers any submarine lamp that would be useful in the silt-laden and black depths of New York Harbour. The men worked in total darkness and were guided alone by their sense of touch and a mental map of the path to be followed in each case, knowledge first secured by studying a metal model, built for the purpose in sections that could be lifted off, deck by deck, to visualise the path to be taken within the sunken craft.

It was not possible for the divers to reach some of their objectives until the adjoining spaces had been made accessible and intervening obstructions removed by the divers themselves. When the "Lafayette" capsized, all furniture and fittings not securely fastened in place, stores, and much equipment within the ship promptly slid or dropped to the low port side and to the lowest point. Dunnage and miscellaneous materials became intermixed with the mud that worked its way into the vessel. The divers had to make their way slowly forward, clearing a path to do so. They had to be mindful of their air and life lines, and to guard against becoming entangled in the *débris* about them, and, above all, not to become confused. That work was entrusted only to the best-fitted and most experienced of the divers on the job. At the time of the fire, there was staging hanging over the port side of the ship, and those working platforms were carried down when the ship capsized, some of them being smashed under the vessel and their timbers driven into the craft through the deadlights of the air ports. Those timbers had to be cut away, which was difficult, by the divers before those workers could close and seal the openings.

Approximately 10,000 cubic yards of mud entered the overturned "Lafayette," and that mud had to be removed as a preliminary to righting and refloating her. Air lifts were used to dispose of the mud. The air lift has many applications in the United States. It is used there to pump water from deep wells and has served admirably in unwatering flooded areas of mine workings. The air lift has even proved economical and effective in pumping an especially viscous petroleum having a base largely of asphalt. It is believed that the tanker "Gutheil," sunk by collision in the Mississippi River in 1912, was the first or among the first on which an air lift was employed to remove a large volume of mud. That ship capsized, and five years passed before she could be righted and refloated. The salvors had to clear out of her oil tanks an accumulation of 4000 tons of river silt. An air lift, devised on the job, saved the day, and was largely responsible for the oiler's successful salvage.

The air lifts used on the "Lafayette" were manœuvred at their intake ends by the divers. Each air lift was made up principally of a flexible 8in. discharge line equipped at the intake end with an annular metal fitting that contained centrally a perforated hollow ring connecting with an air supply coupling on the outside of the terminal casting. To that coupling was connected a hose transmitting operating air at a pressure of 80 lb., and the air was discharged within the pipe in the form of jets from the perforated ring. The natural upward flow of the released air created a suction effect at the intake nozzle, which, combined with the rising column of air and water of reduced specific gravity, and the hydrostatic head outside of the air lift, caused an inward and upward flow of the mud to be removed. This is only one of the many forms of air lifts in wide service, and was a valuable aid in freeing the ship of the mud in her as a preliminary to unwatering her. While the mud was thus being withdrawn, water was permitted to enter the ship to replace the mud and to prevent the development of a differential head.

John I. Tooker, of the Merritt-Chapman and Scott organisation, a man of twenty years' experience in diving and in all phases of marine salvage operations, was made civilian superintendent of the work on the "Lafayette." "Captain" Tooker, as he is generally known in the field of marine salvage, is accredited with having designed the collapsible patch used in first closing all the open air ports on the submerged side of the vessel. The patches had to be passed

outward through the air port, expanded, and then pulled up against the external surface of the ship's skin and secured tightly by running down nuts on to threaded eye bolts. The patch consisted of a two-part wooden disc hinged centrally and carrying a flexible gasket on the surface making contact with the outside of the hull. When the diver had a patch in position covering an air port, he straddled the inside of the air port with a strongback of steel channel through which the eye bolts were passed, after which the nuts were placed on them and run down hard against washers, with pneumatic wrenches wherever possible to use them. Oblong timber patches, not split, but fitted with gaskets, eye bolts, and strongbacks, were used for moderate-sized rectangular openings that had to be closed and which could be easily handled by a single diver.

The cargo ports, equipped with sliding doors, on the submerged port side, were closed by divers and then secured and sealed with I beams embedded in tremie-poured concrete to make sure of water-tightness. This work, of course, was done from within the wreck. The much larger turbine, boiler, and cargo hatches, &c., on the submerged half of the promenade deck were closed with patches constructed of timber reinforced with large I beams. The planking used was about 4in. thick, and some of these box-like structures were 20ft. by 50ft. in plan and 3ft. through. The three main patches of this description had a total weight of 150 tons, and they were anchored in place by hook bolts that engaged the underside of the hatch framing, and were drawn tight with nuts at the outside end, which were run down by divers. These large patches had centrally smaller hatches through which the divers could enter and leave the ship, those openings being closed when it was no longer necessary for the divers to make use of them. Flood valves fitted to these big patches, with long stems reaching up above the surface of the slip, permitted the river water to enter and leave the vessel freely during tidal changes before the valves were closed just preceding the start of the controlled pumping of the craft. The openings closed by patches required 5447 square feet of such closures, and the divers drove plugs, wedges, and attached small patches numbering all told 4500. So much for the closure of deck and shell openings completed under water.

(To be continued)

Engineers and the British Empire

By Professor MIDDLETON SMITH, M.Sc., M.I. Mech. E., LL.D.

No. XX—*(Continued from page 383, November 12th)*

The Diamond Mines in South Africa

ONE day in 1867 the Colonial Secretary laid upon the table of the Cape Legislature a then recently discovered diamond. He said: "Gentlemen, this is the rock on which the future success of South Africa will be built." As has so often happened in mining history, the first sign of mineral wealth was picked up by accident. A child on a Boer farm was playing with pebbles when a trader noticed one of them that seemed to resemble the diamond in his ring. After delays and adventures, the trader sold the stone for £500, half of which he gave to the Boer farmer. The story stimulated fortune-hunters to search the banks of the Vaal and Orange rivers, but the next discovery, again made by accident, took place in 1870 in dry diggings. Then commenced the rush to peg out claims. In July there were 1000 diggers in the alluvial area, and in October 5000 were at work. Malarial fever raged. The water was bad, and, after the wells were dry, was sold for 10s. a barrel. Diggers washed in soda water, brought 700 miles from Cape Town. Cauliflowers were sold at 20s. each. There were plagues of fleas, flies, and sand-storms, but the rush went on. In 1875 it was officially reported that diamonds worth £3,000,000 were being annually exported, and imports valued at £2,000,000 went to the diamond diggings.

In November, 1871, a tall lad, eighteen years old, named Cecil Rhodes, left cotton planting in Natal to join in the rush. He arrived at the diggings "in a Scotch cart drawn by a team of oxen, carrying with him a bucket and spade, several volumes of the classics, and a Greek lexicon." Eighteen years later this unknown young Englishman had brought about controlled marketing and amalgamation of the diamond industry. In 1889 he bought the world-famous Kimberley Mine with a cheque for £5,338,360.

The discovery of diamond pipes showed that diamonds were to be found at great depths, and this meant the application of engineering science for haulage and drainage. Subterranean mining for diamonds began in 1883. More costly machinery was needed, more white labour. There were wild orgies of speculation in diamond shares, followed by slumps and resulting lack of confidence in the industry. Native servants robbed the diggers. Illicit diamond buying became general until the law made "I.D.B." a crime, and provided a fertile field from which novelists gleaned exciting stories, true and untrue, while rumour associated the names of more than one millionaire with the "I.D.B." racket. Rhodes finally produced order out of chaos and the industry has, since his successful work, been on a stable foundation.

There was romance and clever reasoning connected with the discovery of the greatest of all the diamond mines, the "Premier," by Sir Thomas Cullinan. He was prospecting near that mine in 1898 when he came to the conclusion that the alluvial diamonds he saw there came from a higher level. He had to wait until the Boer War ended, when he bought a farm for £52,000. On the highest point of the hill he sank his shafts. In 1905 his mine produced the largest stone yet found—the famous Cullinan diamond. It weighed 3023 carats in the rough, and measured 4·5in. by 2·25in. by 2in. It was cut into nine large and about 100 smaller stones, some of which are now in the crowns and sceptres of our King and Queen.

Later, thousands of men were working night and day in the Premier Mine. There was the frequent sound of blasting, then the movement of trollies, the crushing of the blue earth, until the final stage of hand sorting the treasure was reached. For every 12,000 tons of blue spoil hauled up, only 1 cubic foot remained for hand sorting. Up to 1928 the mine had yielded 6·5 tons of diamonds, worth £28,500,000 sterling. It is said to be practically inexhaustible.

The London Diamond Syndicate controls the diamond market, and by the aid of legislation designed by South African statesmen and financiers, prevents fluctuation of prices and over-production. Diamonds have been discovered in great quantities in South-West Africa, in Angola, and elsewhere, but the organisation of the industry enables thousands of men to make a living in the mines and alluvial fields in South Africa.

The De Beers Company practically owns all the diamond mines in production in the Cape Province. In one mine a depth of 3601ft. was reached; it was subsequently abandoned and water pumping was stopped in 1914. In the Orange Free State are the well-known Jagersfontein and Koffiefontein mines. When at full work, the first-named mine employed 400 whites and 3500 natives. It was discovered in 1878. In 1893 it produced the largest white diamond found up to that date. The total weight was 971 carats and the greatest measurement was 5·5in. round. The mine, in common with many others, was closed down in 1932, owing to the world-wide economic depression. The probability of reopening the mine was, in 1939, said to be remote. The Koffiefontein Mine, controlled by De Beers, has had shafts carried to a depth of several hundred feet. Mining has been recommenced on a small scale.

In the Transvaal the Premier Mine, the largest of all diamond mines, began operations in 1902. Of the profits, 60 per cent. belongs to the Government, in addition to income tax and export duty. The mine closed down in 1932, after making losses, throwing out of employment 350 whites and 1500 natives. The outlook for early opening is not considered to be encouraging.

The Southern African diamond industry, with all its ramifications, is controlled in Kimberley. This limits the output of the Union, South-West Africa, and the Congo. The upkeep of the price of diamonds is a problem of great difficulty. A few years ago De Beers and Jagersfontein supplied 85 per cent. of the world's diamonds. In 1932, before the closing of some mines, the yield of the Union had fallen to 42·8 per cent. As a luxury trade it depends upon world-wide prosperity.

Industrial Diamonds

The early diamond drills had steam engines for motive power, which served both to turn the chuck for rotating the rods and to hoist the rods out of the hole. In some cases the steam outfit has been replaced by internal combustion engines or electrically driven drills; in Africa, for deep holes and difficult drilling, the steam drill seemed to be largely favoured, but for shallow holes the petrol engine drill is used. Speed of rotation of the drills has increased from 200 r.p.m., with a "carbon" bit, to as much as 1200 r.p.m., with petrol-driven drills, using "boart" bits in shallow holes. Up to 1930 the diamonds used in setting the bits were "carbons," black amorphous diamonds from Brazil—very tough diamonds. The "boart" diamonds are crystalline diamonds not fit to be cut into gems. They cost £20 in place of £100 for a good "carbon" bit.

In 1940 industries in the United States, working under stress of war production, consumed more than 2,000,000 carats of industrial diamonds, and Britain's industrial requirements have greatly increased. The sales of the Diamond Trading Company are reported to have increased 112 per cent. in 1942 over those of 1941 with "boart" sales, increasing over that period by several million carats. In the last thirty years the use of industrial diamonds has increased eight-fold. It is said that more than a quarter of the industrial diamonds sold by the above-named company are used for setting in

machine tools. The diamond has stepped up the production of armaments to a speed which ten years ago seemed impossible.

The revival of industry in Britain and elsewhere has created an active market in South Africa, particularly for flat diamonds of ½ to 1 carat for wire drawing. "Bort" is an impure form of diamond, often opaque and black, used in drills and other tools as diamond powder. The true "Carbonado" diamonds are not found in South Africa, although they have been reported from time to time. They are used for rock drilling purposes, &c. The supply has come from Brazil.

In 1937 there was great interest in the possible introduction of mining drills with diamond heads, for use in the gold mines. Advantages claimed were dust prevention and low power consumption. Experiments were made with a "gold cutter" consisting of a small diamond-studded wheel revolving at a high speed. It was believed that this method would replace to some extent the usual drilling and blasting method.

Coal in the Union

As far as is at present known, Africa as a whole is poorly endowed with coal. The Union is believed to contain over 90 per cent. of the known African deposits and Rhodesia probably 3 per cent. South African coal is, with the exception of East Indian, the cheapest in the world.

In 1936 there were seventy-six collieries at work in the Union. The industry employed 1766 whites and 28,454 natives and coloured, the latter being the term often used for Euro-Africans. The total tonnage (2000 lb. per ton) output for 1938 was about 17½ million. The Transvaal supplied just over 11½ million, the value at the pit's mouth there being just under 5s. per ton. Natal supplied about 4½ million, the value being 6s. 9d.; while the figures for the Orange Free State were just over 1½ million and 4s. 9d. The Cape Province output was almost negligible—3108 tons, at a value slightly in excess of 11s. 4d. per ton. Most of the coal for bunkers and export goes to Durban, Lourenzo Marques, and Cape Town. It is notable that calls made at Durban by ships burning oil instead of coal increased from 253 in 1932 to 694 in 1938.

Coal in Natal was first reported in a dispatch sent in 1839 to the Imperial Government. Costly alterations were made in the Natal main line—now electrified—to facilitate the development of the export and bunker business. In six years coal sales in Natal increased from about 3 million to over 4½ million tons. In 1938 some 180,025 tons of coke were produced and 282,823 gallons of tar in Natal.

Coal in the Orange Free State is mined in the neighbourhood of Vereeniging, but it is known to exist over a wide area in that province, and will probably be worked in due course. In the Transvaal the superabundance of good and cheap coal in the same neighbourhood as the gold mines has been invaluable. On the East Rand the gold reefs are actually overlaid by the coal measures. Transvaal coal was successfully coked in 1931. The development of iron smelting on a large scale at Pretoria led to the production of coke. Some plants are equipped for the recovery of tar and its derivatives.

The "Iscor" Works

A State ironworks, on a very large scale, began operations early in 1930 on a site west of Pretoria. Production of primary steel products, such as rods, rails, and building sections, commenced in 1934. The first blast-furnace was lit in that year. A profit-making stage was reached in the next year. In 1939 plant to construct 30,000 tons of wire per annum was under consideration. The authorised capital of the South African Iron and Steel Corporation ("Iscor") is £7½ million, including debentures.

This State undertaking is almost unique in that it comprises the whole process of steel-making from the coking of the coal to the finished products. In 1938 some 458,317 tons of coal were consumed, about 300,000 tons of pig iron produced, and also 330,201 tons of steel ingots, large quantities of tar, motor spirit, benzol, naphthalene products, &c., became available. In 1934 the railways contracted for ten years to take all their requirements the company could supply. Even when the extensions planned in 1938 were completed, it was estimated that two-thirds of the iron and steel needed would be imported. That took no account of the increase in demand due to the war. In 1938 about 3250 Europeans were employed. The millionth ton of steel was produced in 1938.

A new undertaking, called the Vanderbijl Steel Works, has been designed to operate with cold slabs, sent by rail from the Iscor Works. A plate mill of the latest American design will roll plates to the required size. The new mill is situated near to Pretoria. A new branch railway and a new road have been constructed. The excavation for the mill, buildings, &c., was commenced in August last year, and the necessary water supply, drainage of works area, power and light supply, and housing accommodation had made good progress, according to the latest reports. As some indication of the size of the plant it may be mentioned that, at peak load, the main mill driving motor will take power equal to 17,000 H.P. A detailed description of the works was given in a recent issue of The Engineer.*

The Demand for Metals

Although mining for metals is a pursuit of great antiquity, it was not until the early part of the nineteenth century, when the steam engine made much greater power available, that mining became an important industry. To-day the use of metals is the very basis of industrial civilisation. Gold is essential for making easy the exchange of commodities; it acts as a fly-wheel for international commerce. In a book "The Gold Fields," published by the Consolidated Gold Fields of South Africa, Ltd., in 1937, it is written: "The output of gold in the second half of the nineteenth century was nearly ten times that of the first half, and in the first thirty-six years of the twentieth century the output of the previous half century had been doubled. The production of base metals has increased in similar proportion, so that the present century has already witnessed a greater output of metals than in all previous time." It gives us some idea of the tremendous increase in mining that will be essential to maintain the new civilisation dependent on mechanised power and metals that is rapidly spreading over all the earth.

The total production of all minerals (including diamonds) in the Union for 1938 was worth just over £98¾ million, of which value the Transvaal contributed more than £91¾ million. The average number of whites and natives employed in mining within the Union during that year was 470,298, of whom 386,607 were in the gold mines, 33,678 in the coal mines, and 20,720 connected with base metal mines.

The Transvaal contains large deposits of chrome, but it is inferior to that obtained in Southern Rhodesia. The high percentage of iron makes the ore unsuitable for the production of ferro-chrome. The yield from the Union, however, increased from 31,327 tons in 1928 to 186,379 tons in 1937. In the latter year the value of the yield was £344,037.

* July 2nd, 1943.

Copper and Asbestos

Copper was the first metal worked in South Africa by white men. In 1919 the grade of ore in the Union fell off seriously. After fifty years of continuous production, amounting to over £20 million worth of copper, the companies had to close down for a time. Ore had been worked to nearly 1000ft. in depth. There is reason to believe that the Union may again be an important copper producer. In 1937 the value of copper sales and shipments was £610,192.

The exploitation of asbestos since 1913 has been remarkable; it advanced South Africa to the first place among the world producers of high-class crude fibre. The sales and shipments from the Union in 1937 were 28,069 (short) tons, valued at £430,761, and from Southern Rhodesia 57,014 (short) tons, valued at £840,026.

Although indications of silver have been found all over South Africa, very little of the metal or its usual associates—lead and zinc—have been produced. The present yield of silver is entirely recovered from gold bullion.

South Africa is an important source of supply of corundum. The stoppage of supplies of an abrasive from Turkey, together with increased demand for munition purposes, led to a rapid rise in production of corundum in the Union.

There is a great quantity of manganese in the country. The output was expected to reach 2000 tons a day and storage of 50,000 tons capacity and loading plant was erected at Durban. Mining, however, ceased in 1931, owing to the depression and Russian competition, but in 1937 the output from the Union was 557,210 tons, worth over £600,000. No doubt the war has greatly stimulated output.

Platinum Output

There is platinum in South Africa. Unlike gold, the metal has not a fixed value. Early prospectors took specimens of the ore, which caused a little "flutter" in the stock market. When the Transvaal Platinum Company was formed, its 5s. shares rapidly rose to £5. Many other projects were floated, but the serious investor was far less interested than the speculator. The platinum "boom" proved to be little more than a huge gamble, but it did remind people that South Africa had been only very incompletely explored by the geologist and the mineralogist, and was likely to contain many valuable minerals, in addition to its proved stores of gold and diamonds. When searching for platinum, men found other things—tin, chrome, or manganese, or even only country suitable for farmers.

Since 1924 the Union has become an important competitor in the production of platinum with Russia, Canada, and Columbia. In 1926 there were sixty platinum companies, with a market valuation of £10 million; in 1938 the capital invested was valued at just over £3 million. In 1927, when the Russian Government increased its exports, the metal fell from about £30 to £12 per oz., and later the value fell to £5½ per oz., but in September, 1939, it was £10. In 1927 the Union sales of platinum and allied metals were worth £144,191; in 1932 the value fell to £42,352; but in 1938 it was £223,778.

The Union has become an exporter of manganese ore. Production began in 1929.

Eight years later a record output of 557,210 short tons placed South Africa third among the world's producers, the output being exceeded only by Russia and India. Production in 1940 fell to 454,233 short tons, due to the fact that the export market in Europe was closed. The U.S.A. was then the sole importer from South Africa. The deposits at Postmasburg are situated some 130 miles by rail north-west of Kimberley; an extension of the line was made to serve the mines where a crushing and sorting plant had been erected. The ore is transported for shipment to Durban. Manganese is of immense importance to the steel industry, which is said to absorb about 92 per cent. of the total world production. Figures show that in steel production there was a consumption of 53·7 lb. of manganese ore per ton of steel made.

The Union produces a variety of metals, but the combined output of all others in no way approaches that of gold in value. A few weeks ago the Anglo-American Corporation of South Africa announced that a new company is being formed, with an initial capital of £2,000,000, to open up an ultra deep mine in the Far West Rand. The expenditure required will be considerably greater than for an ordinary Rand mining proposition. Engineers will watch with interest the solution of the technical problems involved.

The Credit for Prosperity

To the mining engineer must go the greatest credit for the economic development of South Africa. From his office desk radiate many lines of communication to the various parts of the mines. The engineer and surveyor have prepared maps of every inch of a mine. As the advance is made through the workings, average samples are obtained, pounded by the assayers, and then the furnace produces a tiny weight of gold, which, compared with the weight of the sample of rock, gives the true assay value. Every mine has its own problems, and every mining engineer must keep up to date with scientific processes and scientific management.

The early comers to the Rand, who called themselves mining engineers, were a mixed lot. They had been Army officers, sugar planters, farmers, overseers from the diamond mines, perhaps with executive experience and ability, but provided with little equipment and no knowledge of gold mining; yet they were able to build the foundations of a great industry. There were many failures, and as the scale of operations increased, the need for scientific experts became manifest. The engineers who were brought to the Rand had had experience in gold mining in many parts of the world, from Korea to Arizona. There are many romantic stories told of some of these mining engineers. For example, Robert Williams guided Cecil Rhodes to the Congo, but King Leopold secured the country because the British Government hesitated to enlarge Empire territory. Williams did succeed in obtaining mining rights for copper in the Congo; he was of great assistance to Rhodes in connection with railway building and the development of the natural resources of the Rhodesias. They were great friends and remarkable Empire builders—Rhodes the visionary and Williams the practical planner.

It should be emphasised that it is the work of engineers that has brought prosperity to South Africa. The world in general has benefited by the immense increase in production of raw materials that the Union has supplied.

The mineral resources of the Union have aggregated in value vast sums, but the great output of gold has represented about 77 per cent. of the total value of the minerals produced. At the end of 1938 the aggregate mineral output of the Union had reached more than £2,159,000,000. Gold accounted for £1,657,660,534; diamonds, £327,771,889; coal, £115,820,785; copper, £30,322,785; all the other minerals — platinum, asbestos, manganese, &c. — contributed less than £10,000,000 each to the total. From time to time some new mineral has been produced, and it is not improbable that others will be revealed.

Water Supply

When gold was first discovered miners stood in queues to obtain a tin of water. Carters carried water from distant wells and sold it in the streets. Nature supplies to the Rand an adequate annual rainfall, but it comes suddenly in summer. Much of it drains away, for Johannesburg is on the very top of the high veld. It is said that the rain that falls off one side of a house runs towards the Atlantic and on the other side it goes to the Indian Ocean.

The Rand Water Board nowadays pumps 65 million gallons of water every day from the plant at Vereeniging into Johannesburg and on to the Rand. A barrage was built on the Vaal River some 20 miles below Vereeniging, at a cost of £1,320,000. The sedimentation tanks cover 12 acres. There are six systems of pumps, which force the water up over hills to a maximum height of about 2000ft., and send it through more than 480 miles of mains. The demand for water increased to such an extent that the Government built another dam on the Vaal, so that an additional 150 million gallons a day can be supplied. From 35 to 40 million gallons a day are pumped up from underground diggings and used by mineowners.

In the early days of colonisation, the total absence of internal water communication, whether by river or canal, was a great impediment to transport. The coasting trade was precarious. The coast provided no shelter in bays or natural harbours. In Cape Colony the course of the rivers is short, and they are liable to become swollen streams in the rainy season, drying up into brooks when the dry periods come. Further north the Orange and the Vaal rivers have torrential floods and steep falls, so that navigation on them is impossible.

The system of dry farming was introduced after it had proved successful in the semi-arid west of the United States. It involves deep ploughing followed by pulverisation of the soil by constant tillage. That enables the soil to retain the maximum amount of moisture. A Select Committee (1911) recommended dry farming for land settlement rather than irrigation schemes, which were considered costly and for success demanded more time and experience than dry farming. It was stated that even a minimum annual rainfall of 10in. offers a reasonable prospect of success for the energetic and intelligent dry farmer.

Nevertheless, it has been shown that irrigation does pay in certain areas. Practically all the wheat grown in the Transvaal is produced on irrigated lands. There has been in many of the older settled areas of the Cape Province deterioration of the land, with the inevitable result of soil erosion, causing a decrease in population. It is clear that the only remedy is the impounding and distribution of such water as is available, but the remedy cannot be applied in any extensive manner. "Generally speaking, in the Karroo system, which covers 50 per cent. of the Union, the soil is very thin, and does not justify the cost of irrigation works." That was the statement of experts in 1914.

The general system is to avoid the expense of a reservoir and to build a weir across a river bed. When the river floods the water is distributed by furrows over as wide an area as possible. There is a Government scheme which was planned to irrigate 40,000 acres. A dam, costing £1,600,000, was erected about 25 miles west of Pretoria, and forms a reservoir of 6½ square miles. This impounds water from the Crocodile River. Cecil Rhodes had advocated a more ambitious project for the Hartz River Valley to be supplied by water from the Vaal. The Government, in 1934, commenced this work to irrigate 100,000 acres.

The waters of the Great Fish River are used for two schemes, the Tarka and the Grass Ridge schemes, which irrigate over 55,000 acres. About 140 miles north-west of Port Elizabeth, at Van Ryneveld Pass, the sources of the Sandys River have been dammed to irrigate 22,000 acres. The dam is 1170ft. long and 151ft. high. The Lake Mentz scheme also utilises the Sandys River, and, with the Van Ryneveld Pass scheme, irrigates 70,000 acres.

The problem of irrigation presents many difficulties. In the coast regions, where the rainfall is plentiful, the surplus water cannot be supplied to the higher inland plateau. There are no natural reservoirs provided by snow-clad mountain ranges. Sir W. Wilcocks estimated (1901) that 3,000,000 acres could be irrigated; he did not state that the schemes would pay. The Director of Irrigation stated (1930) that the maximum economically irrigable area in the Union is 1,000,000 acres. The total Government expenditure up to March, 1938, on irrigation works, including loans, was £15½ million and some 75 per cent. was a financial loss, although it is suggested that indirectly the results may be more encouraging than the figures suggest.

Evaporation is rapid and complicates water supply problems. A free water surface in London gives up 15½in. a year; at Johannesburg, 61¾in.; at Kimberley, 82¾in.; at the Molteno Reservoir, Cape Town, 306ft. above sea level, 78·57in.; at Bulawayo, 101·87in.

Up to 1938 the Government had spent nearly £2¾ million on boring for water. Wells or bore-holes may supply water to areas that may become habitable, and profitable where other supplies are not available. In 1894 the Cape Colony Government commenced boring operations, and since then almost every part of the province has been explored. Some 9500 bore-holes have been drilled, and give an aggregate supply of many millions of gallons daily. The depths vary from 50ft. to 500ft. Since the formation of the Union, the Irrigation Department has been working with State-owned machinery. There are now over 60,000 bore-holes in the Union. Some 100 drills can be hired out at reasonable charges, and machinery, together with experienced men to work it, to aid the farmers. The demand has been beyond the capacity of the boring branch in some periods. The scheme is a success.

Surprise has often been expressed in Africa that so many rivers have been allowed to flow unchecked to the sea. Professor Schwaz caused a great deal of controversy by suggesting that the waters of the Zambesi, which pour over the Victoria Falls and on into the Indian Ocean, and the River Cunene, which flows into the Atlantic, might be diverted to irrigate areas in the Kalahari desert. But the proposal received very little support.

(To be continued)

Local Case-Hardening

By L. G. WHYBROW PALETHORPE, F.I.C.

THE case-hardening process is very much used by engineering designers as the one really efficient method of obtaining a tool-hard, wear-resisting surface, together with a tough, shock-resisting core. However, by virtue of the nature of the job in hand, it is often neither desirable nor practicable to harden all over. For example, a steel shaft screwed at one end may require to be case-hardened all over except for the thread, or a clutch wheel may only want hardening on the teeth, and so on. Thus, when only part of a job is to be hardened, carburisation of the surface of it must be selective.

Perhaps one of the oldest methods of case-hardening locally is by the process known as "potashing." This consists of heating the part required to be hard until it is cherry-red hot and then covering it with "potash" (potassium ferrocyanide), followed by soaking at red heat for a few minutes, and finally quenching in water. Although it is somewhat primitive, it is quite effective for small work. The point to remember is that the case obtained is never very deep, being of the order of 0·005in. at the most.

Apart from potashing, there are three fundamental methods of selective case-hardening, each of which is based on the principle of insulating from the carburising medium the area required to remain soft. Each has its advantages when considered in relation to the carburising process employed, namely, box, gas, or cyanide. They are:—(1) Protection of the area required soft by the use of clay or proprietary compounds; (2) protection of the area required soft by electroplating it with copper; (3) protection of the area required soft by stock left on until after carburising followed by removing it prior to hardening.

Protection by Clay, &c.

Generally speaking, the use of clay is not very satisfactory. In box and gas carburising, the reaction is essentially a gas-solid one. This is obvious in the case of the gas process, but in the box process (pack hardening) it is apt to be overlooked. The carbonaceous material of the compound combines with air in the box to form carbon monoxide which takes a direct part in the reaction. Thus it will be understood that the carburising gases completely surround the work being treated.

When using clay as a protecting medium, it is applied wet and by the time it reaches the carburising temperature it has usually cracked badly and the protection it affords is only partial at the best. The active gases penetrate the cracks and the area required soft will have hard spots when quenched.

The proprietary compounds are an improvement on clay. They are specially blended to render them non-cracking, and the protection they afford is more complete.

In the cyanide process the use of clay and proprietary compounds is decidedly unsatisfactory. The fused salts attack and dissolve the clay, thus permitting carburisation to proceed. In addition, the salt becomes contaminated and useless.

Protection by Copper Plating

Within limits, it is true to say that copper plating affords some measure of protection against all three carburising media. In the box and gas processes the protection is very good. Cyanide, however, tends to dissolve the copper, and therefore heavier deposits must be used. It has been suggested that the dissolved copper has a "poisoning" effect on the salt, but, so far as the writer is aware, there has been no proof of this. Thus by varying the thickness of the copper deposit, this method can be used for all three carburising processes. Its success depends entirely on the quality of the plating.

The following practice is recommended for the best results:—First of all, the work to be plated must be thoroughly cleaned and freed from oil and grease. Rust and scale must be removed by pickling in 20 per cent. hydrochloric acid, followed by rinsing thoroughly in cold water. Even in the absence of rust, a short-time immersion in an acid-pickling solution is beneficial in that it helps the copper to "bite."

The plating solution should be of the cyanide type, containing 2½ per cent. of sodium and copper cyanides and a little sodium carbonate, say, approximately ½ per cent. The current density may be up to 40 amperes per square foot, and the working temperatures should be controlled at between 100 deg. and 120 deg. Fah. The advantage of this type of solution over sulphate solutions is that a smooth, closely adhering, and non-porous deposit is obtained. However, if a thick deposit is required, a cyanide solution may be used to give the foundation to a further deposit from a sulphate solution. The thickness of deposit required for use in the box process is 0·0005in. to 0·001in., but in the cyanide process greater thicknesses are usually required. The relationship between the depth of case required (time of immersion) and the thickness of copper deposit necessary for insulation from the cyanide carburising medium is shown in the accompanying table:—

Relationship Between Time of Immersion in Cyanide and Thickness of Copper Deposit Required

Time of immersion in cyanide.	Thickness of copper deposit required. Inch.
One hour	0·0005
Two hours	0·001
Three hours	0·0015
Four hours	0·002
Five hours and above	0·003

Of course, only the "required soft" areas are copper plated. The "required hard" areas must eventually be exposed to the carburising medium. This can be done in one of two ways. If the entire job is plated in the first instance, then copper can be removed from the "required hard" areas, using a buffing wheel, a file, or a scraper; or the "required hard" areas may be stopped off, *i.e.*, they are painted with a lacquer, preferably of the cellulose type, in order to prevent the deposition of copper on them. Having prepared the job, therefore, copper plated where required soft and not so where required hard, the case-hardening process is carried through in the ordinary way, carburisation being limited to the selected areas.

When using electro-deposited copper as a protecting medium, two points must be watched carefully. The deposit must be completely non-porous in order to prevent the active carburising agent from making contact with the surface of the steel. This it should be if the above procedure is adhered to. Square corners must be avoided if any machining is to be done after case-hardening. This is of particular importance if a job has holes in it, which have to be reamed as a final operation, because, as a rule, it is found that the holes are hard. Consequently, the reamers are spoiled. This trouble is due to the fact that the metal from electro-plating baths does not "throw" well on to square corners. The resultant deposit is therefore thin and pervious to the active carburising agent. To overcome this drawback sharp corners must be rounded off and holes must be countersunk.

Protection by Stock

This method is extremely effective for all processes of carburisation, provided that slow cooling from the carburising temperature is ensured. The reason for slow cooling is obvious, because rapid cooling would cause premature hardening and unmachinability. The method is based on the principle that if stock over and above the finished size is left on parts required to be left soft, the whole job may be carburised. Then, provided that the cooling from the carburising temperature has been slow, the excess stock, less the usual grinding allowance, may be machined away, leaving uncarburised surfaces exposed where softness is required and carburised surfaces where hardness is required. Thus when the job is quenched hardening will be limited to the required areas.

In the box and gas processes slow cooling can be effected by allowing the work to cool either in the box or in the furnace. In the cyanide process, however, it is more troublesome to ensure slow cooling. The work cannot, for obvious reasons, be cooled in the salt. Therefore other arrangements have to be made. If the furnace is fitted with a pre-heater, it may be used to slow down the cooling for plain carbon steels. For alloy, steels, however, it is less satisfactory on account of the air-hardening properties of the carburised steel. The best method perhaps is as follows:—When the work is removed from the salt it should be transferred immediately to a box with a well-fitting lid and allowed to cool slowly. If it can be arranged, it is an advantage to pass a stream of coal gas through the box, allowing it to burn at the outlet. Alternatively, and this can be applied to the box and gas processes, work may be quenched in oil direct from carburising, followed by tempering at a temperature of 600 deg. to 650 deg. Cent. This will render parts made in any steel quite easily machinable.

The amount of stock left over and above the finished size of a job is governed by the depth of case required. If it is practicable the allowance should be generous, so that there is no doubt that all of the carbon penetration is removed. Having removed the stock where necessary, hardening is carried out in the usual way, and only in the places where the carbon has not been machined away will its effect be felt.

Comparison of the Three Methods

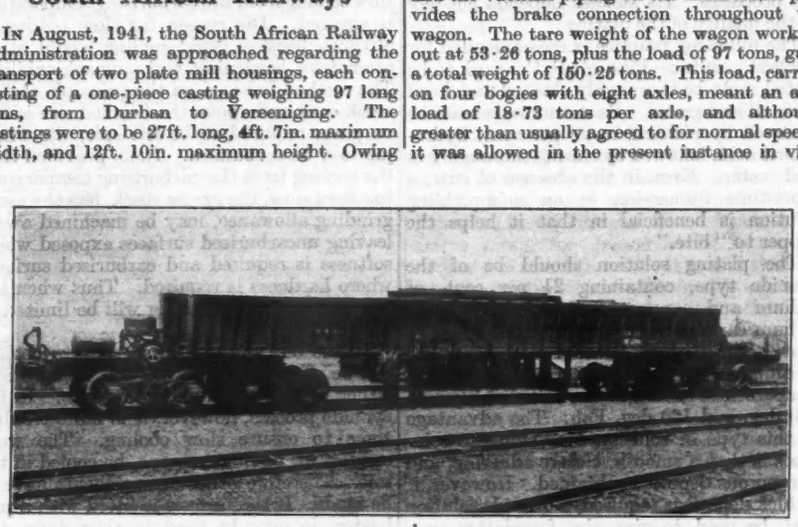
As mentioned earlier, each method of selective carburising has its advantages when considered in relation to the carburising process employed. Speaking generally, and without consideration of the idiosyncrasies of any particular work, the third method, that of protection by excess stock, is the most efficient, particularly in the box and gas processes. Sometimes, however, especially in the case of stampings, excess stock cannot be left, and then the plating method of protection must be used. As far as the cyanide process is concerned, the writer does not use it for local case-hardening as a rule, on account of the extra trouble necessary to ensure slow cooling and good machinability after carburising.

Finally, the writer would stress the point that, apart from the "clay" method, local case-hardening is relatively expensive. Consequently, many engineers wish to avoid the

cost of copper plating or extra machining, and risk the quality of the job. If work is required to be case-hardened locally, then, to produce a satisfactory finished article, the evils of extra operations and expense must be endured.

Wagon for Special Load on South African Railways

In August, 1941, the South African Railway Administration was approached regarding the transport of two plate mill housings, each consisting of a one-piece casting weighing 97 long tons, from Durban to Vereeniging. The castings were to be 27ft. long, 4ft. 7in. maximum width, and 12ft. 10in. maximum height. Owing to their weight, size, and shape, it was not possible to carry them on any standard wagon in service. Their weight plus the tare of the largest standard "U.S." type twelve-wheeled wagon of 32·8 tons gave an axle load of 21·6 tons, which is not permissible.



WAGON FOR SPECIAL LOAD

As the plate mill housings for the Vanderbijl Works at Vereeniging were essential if South Africa were to appear on the map at an early date as a producer of heavier steel plates than are now rolled at the Pretoria works of the South African Iron and Steel Industrial Corporation, Ltd., the Administration was requested to ascertain what could be done to overcome this and other difficulties. After mature consideration a satisfactory general design for a special wagon was brought to fruition in the carriage and wagon drawing-office under the direction of the chief mechanical engineer at Pretoria.

Specially Built Wagon

The specially built wagon illustrated consists of a main frame pivoting on two auxiliary frames spaced at 48ft. centres, the latter frames being each supported on two standard diamond frame bogies spaced at 10ft. 3in. centres, that is to say, a total of sixteen wheels with eight axles. All pivot centres work in oil baths, which is the standard practice for new wagons.

After the general design of the special wagon had been decided upon, the Iron and Steel Corporation agreed to design and fabricate the main frame at their Iscor works, which was duly done and the frame dispatched to Germiston, the complete wagon being otherwise fabricated and thereafter assembled at the latter workshops. The main frame consists of two girders built up of plates and angles, the dimensions being 53ft. long, 4ft. deep, and 7ft. 6in. wide, and the weight approximately 60,000 lb., with an additional underslung structure extending at its lower part to within 5in. of rail level when the wagon is fully loaded. The actual load is supported between the two girders by eight removable channel cross members fitted across the top of the frame and also by cross members riveted to the bottom of the underslung structure, cross braces also being used to stiffen the frame.

As the main frame is a costly structure and there is little likelihood of its being further utilised as a component of a wagon in future, it was designed to enable it to be put to subsequent permanent use in the extensions now taking place at one or other of the steel works controlled by the corporation.

The auxiliary frames are of a single-box girder design, also fabricated from plates and angles, the main dimensions being 17ft. 9½in. long, 2ft. 10in. wide, and 1ft. 2¼in. deep, with cantilever supports for side frictions of the main frame and bogies. The draw gear and vacuum brake gear are fitted to these frames and the vacuum piping on the main frame provides the brake connection throughout the wagon. The tare weight of the wagon working out at 53·26 tons, plus the load of 97 tons, gave a total weight of 150·25 tons. This load, carried on four bogies with eight axles, meant an axle load of 18·73 tons per axle, and although greater than usually agreed to for normal speeds, it was allowed in the present instance in view of the fact that a restricted speed was in any case considered necessary.

Test for 100-Ton Crane

Another difficulty was the absence of a 100-ton crane to lift the loads from ship to wharf and from wharf to wagon. The largest suitable crane is rated at 80 tons capacity only, whereas the loads to be lifted were of 97 tons. However, the matter was fully explored and, as the 80-ton crane referred to was guaranteed and tested for an overload of 25 per cent., authority was given to use it as a special case under expert supervision. Special steps were taken to overhaul the crane, and a trial lift of 100 tons was made to ensure that it was in thoroughly sound condition before attempting to raise the loads from the ship's hold. The height of the load was the only dimension that might have proved troublesome, in so far as the railway loading gauge was concerned. However, allowing 5in. clearance between the bottom of the load and rail level, plus 12ft. 10in. height of load, this worked out at 13ft. 3in., which is the maximum permissible height in accordance with the S.A.R. special loading gauge, and it was therefore approved.

LOAD ON WAGON

No hitch whatever occurred when offloading. The mill housings were lying on their sides in the ship's hold and it was necessary to land them on the wharf in that position. From the moment that the crane slings were dropped into the hold a period of only one hour and ten minutes was taken to land the first load on the wharf, including the adjustment of slings to obtain proper balance and the insertion of wood packing to prevent the slings and load from slipping. The second load was landed in even less time, and considerable credit is due to all concerned.

The wagon being partially dismantled, the load was hoisted by the crane over it and lowered into position between the main frame girders. The eight removable top channel cross members were then bolted, adjusted, and positioned by the wood packing to enable the load to be supported by both top and bottom of the main frame, the crane being used to support the load whilst these operations were being performed. The diagonal bearings were thereafter fixed in position and the whole structure wedged by hardwood packing to form a compact mass.

Owing to the limited rail clearance and the height and unusual nature of the load, travel was restricted to daylight and a speed limit of 15 m.p.h. was imposed.

The journey from Durban to Vereeniging of the first of the two castings occupied six days. The description of the special truck and the photographs illustrating it which we reproduce were kindly furnished by the South African Railways and Harbours, to whom acknowledgment and thanks are tendered.

The Design of Tea Boilers

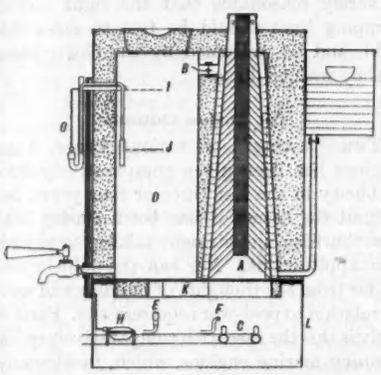
The design of a boiler for providing water for tea-making in canteens, &c., is governed by two important demands which the apparatus must fulfil. First, in order that there shall be no undue delay in making tea, a certain minimum rate of delivery must be maintained, depending on the number of people to be served at one time. Even with a small canteen of about fifty people this rate cannot conveniently be less than 15 gallons per hour, whereby if only one half-pint of water is required by each person, a period of 13 min. will be required for the delivery of the water. Secondly, the water in the boiler must always be at the boiling point.

This problem is often tackled directly in gas boilers by constructing a heater capable of delivering boiling water at the required rate and maintaining the water at the boiling point by means of a by-pass flame when no withdrawal is being made. To obtain efficiently the rapid heating required to deliver boiling water at a rate at least as great as 15 gallons per hour, a large heating surface must be used, and therefore, conversely, when the gas is turned down the rate of heat loss from the surface is large unless the flue is fitted with an automatic damper. It is naturally impossible to lag this surface and therefore a relatively high gas consumption is necessary on the by-pass to maintain the water at the boiling point.

It is characteristic of the service which boilers have to perform in canteens providing tea at certain fixed periods during the day that the full demand is only required during a small fraction of the total time the boiler is in operation. During the major part of the time the water is being maintained at the boiling point on the by-pass flame. When the by-pass consumption is high, it has been found that, of the total gas used, about 50 per cent. may be required to deliver the water and the rest keeps the water at the boiling point. It is quite possible that under some conditions of canteen operation the gas used for the latter purpose

may exceed the former. Therefore, although the heater may have been carefully planned to work at a high efficiency when delivering water, much of the benefit is lost in service when the by-pass consumption makes the overall efficiency only about half that of the heater. If there is such freedom of control that the by-pass gas can be increased by the operator when scaling of the water side of the heating surfaces makes the delivery of boiling water no longer instantaneous, the overall efficiency in some designs may fall into the region of 10 to 15 per cent.

Rate of delivery and heating surface which are so inconveniently interrelated in this type of boiler can be separated by combining together a small water heater and a storage boiler, so that a considerable quantity of boiling water is initially available in the latter and all water withdrawn is replaced more slowly by the heater. The rate of delivery from the boiler depends only on the bore of the tap and the quantity of water available over short periods of heavy demand. By lagging the combination a small flame playing on a small exposed heating surface of the storage boiler is sufficient to keep the water at the boiling point, and it is possible to dispense with the by-pass flame for the water heater, because boiling water is now always available from the storage boiler. The water heater has a small capacity and heating surface, and soon begins to replace water withdrawn when the gas is switched on. As an example of the service which can be provided in a design which combines a storage boiler of 3 gallons capacity



ARRANGEMENT OF TEA BOILER

and a heater capable of replacing 3 gallons boiling water per hour, a maximum quantity of 6 gallons can be obtained in the first hour when the boiler is full. If 3 gallons are quickly withdrawn, it is necessary to wait for an hour before the same quantity can be again obtained, but half a gallon is available in 10 min., 1 gallon in 20 min., and so on. The boiler therefore contains varying quantities of boiling water. It is also expected that ease of descaling will be a further advantage of this design, because the heater can be made to be easily detachable from the boiler. A boiler of this type is shown diagrammatically in the accompanying sketch.

The heater A, with a conical central flue and outer annular water space, is supplied with water by a small constant level ball valve tank. The water level is normally below the exit B, but when the non-aerated burner C below the flue is switched on and the water boils, the difference in density created causes boiling water to pass over into the storage boiler D. The water in the latter is maintained at the boiling point by a small burner E, which plays directly on to its base. The products of combustion from E pass through a small duct into the water heater flue, which therefore receives some heat even when burner C is turned off. F is a relighting jet for burner C. The gas supply to C is controlled by the water level in the storage boiler D through the "gas switch" G. This consists essentially of a U tube connected to a gas valve closed by a diaphragm H. When the level in D reaches I water overflows into the tubes, quickly filling it and placing a pressure greater than the gas pressure, which is controlled by a governor, on the top of the diaphragm. A siphon tube passes from the side of the U tube above the level I into the storage boiler. When water is withdrawn from the boiler and the level J is reached, the siphon starts and reduces quickly the water pressure in the U tube to an amount less than the gas pressure, thus allowing the diaphragm valve to open. It does not close again until the water level reaches I. In the model the levels I and J correspond to capacities of approximately 4 and 3 gallons respectively. The gas to the burner C is therefore only switched on when at least 1 gallon of water has to be replaced. This eliminates the frequent reheatings and subsequent coolings of the flue, with the corresponding loss in efficiency, which occur when small quantities of water are withdrawn or evaporated and the gas supply is controlled by a valve attached to a float.

The whole unit is enclosed in a cylinder of lagging which can be quickly opened to allow the removal of the water heater A simply by breaking the union at B and the connection to the constant level tank. The insulating material is held against the bottom of the boiler by means of a tray K in which are holes corresponding to the burners C and E and a duct leading the waste gases from E into the flue. The gas governor, diaphragm valve, and burners are attached to the stand L, which supports the lagged unit and is insulated from it by means of an asbestos ring.

For a storage capacity of 4 gallons and a heater capable of replacing 3–4 gallons per hour, the boiler without the constant level tank is a cylinder of height 24in. and diameter 15in.

The design illustrated is due to Mr. S. Bairstow, of the L.M.S. Railway Company's research department.

Sixty Years Ago

Sir William Siemens

On the afternoon of November 5th, 1883, Sir William Siemens, walking home from a scientific meeting, suffered a fall which injured his heart and led to his death a couple of weeks later, on November 18th. Thus died one of four brothers—Werner, William, Carl, and Frederick—who, jointly and severally, contributed greatly to the advancement of pure science and its application to practical industry. Charles William Siemens was born at Lenthe, Hanover, in April, 1823. He received his education at Lübeck, Magdeburg, and the University of Göttingen, and in 1842 he became a pupil in the engine works of Count Stolberg. In 1843 he visited England to introduce an improvement in electro-gilding, which he and his brother Werner had invented. The invention was disposed of on satisfactory terms to Mr. Elkington. During the following year he again visited this country on a similar errand, this time in connection with his invention of the chronometric governor. The device was not very successful commercially in its application to steam engines, but it proved a satisfactory means of regulating the great transit instrument at Greenwich. In 1847 he introduced his regenerative steam engine using superheated steam. An example was set up at Mr. Hicks' works at Bolton, but difficulties intervened to prevent its commercial exploitation. In 1850 Siemens became a British subject. The regenerative idea remained one of his chief preoccupations. In 1851 he described his regenerative condenser for steam engines, and during the following year he devoted much attention to the thermodynamics of the hot air engine. In 1857, in conjunction with his younger brother Frederick, he began his work on improvements in regenerative furnaces for metallurgical purposes. He developed the idea into a practical commercial success in 1861. In 1862 he was naturally led to study improvements in the metallurgy of steel making by the process of fusing together scrap iron and pig iron, subsequently replacing the pig iron wholly or in part by iron ore. Thus was born the open-hearth or Siemens-Martin process of steel making. Simultaneously his active brain was turning towards electrical science, and by 1867 he, in conjunction with his brother Werner, had laid the foundations of the electrical career which absorbed the remainder of his life. . . . It was said of him that when everyone else had given up a particular problem as a bad job, it had only to be taken to Dr. Siemens for him to suggest half a dozen ways of solving it, two of which would be complicated and impracticable, two difficult, and two perfectly satisfactory.

The Utilisation of Small Coals

Over 500 delegates attended the Conference on the Problems in the Utilisation of Small Coals, which was organised by the British Coal Utilisation Research Association, on Wednesday and Thursday, November 10th and 11th. The delegates were welcomed by Sir Evan Williams, President of the Mining Association of Great Britain and of the British Coal Utilisation Research Association. Sir Evan said that he thought that a public discussion on the utilisation of small coals was of vital importance to the war effort, in view of the fact that some 25 million tons a year of coal below ¼in. in size are unavoidably produced in the ordinary course of mining. A good deal of these fuels was, of course, used at collieries for steam raising, and the papers for discussion included contributions from engineers describing the best methods of utilising these coals. Dealing with the papers for the second session, Sir Evan said that the coal industry had for many years been devoting a great deal of work and money to the problems of upgrading small coals, which before 1914 were normally consigned to the waste heap. Before asking Lord Hyndley to declare the Conference open, Sir Evan stated that he thought that the Conference would not only assist the immediate problem of utilising all available supplies of coal, but would also serve as a pointer to the longer-term requirements of British industry.

The Lord Hyndley, G.B.E., in opening the Conference, said that as the war proceeded more and more coal would have to be sent overseas for military purposes, and he believed that the year 1944 and the winter of 1944–45 would present a problem which would without doubt cause grave concern. The country was undoubtedly going to be very short of coal during the coming year. Lord Hyndley then paid tribute to the work of the Ministries' regional fuel engineers and the work which they had carried out in proposing and recommending substitute fuels, and he made it clear that it would be necessary to continue with this substitution. After expressing his appreciation to the authors of the papers which were being discussed by the Conference, Lord Hyndley said that the Government were budgeting to produce 15 million tons of open-cast coal during 1944. Up to the present the output had been in the neighbourhood of 130,000 tons a week, but it was his hope that further machinery would soon arrive to enable this output to be increased. He was convinced that the quality of this coal was being greatly improved, and that it would go on improving. As soon as possible, the bulk of it would be screened.

Papers for the first session were then reviewed by Professor A. M. Bryan, Chairman of the Coal Industry Joint Fuel Efficiency Committee, after which the meeting was thrown open for discussion.

At the second session, on the morning of Thursday, November 11th, the opening address was given by Mr. J. Innes, Director of Open-Cast Coal, Ministry of Fuel and Power, after which papers were reviewed by Mr. T. E. B. Young, general manager of the Bolsover Colliery Company, Ltd. The third and last session was opened by Mr. Herman Lindars, Chairman of Council, British Coal Utilisation Research Association, and the papers were reviewed by Dr. D. T. Davies, Fuel Research Station. The Conference was concluded by an address by Dr. E. W. Smith, C.B.E., President of the Institute of Fuel.

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DEATH

ON November 11th, LEONARD FLETCHER MASSEY, M.I. Mech. E., chairman and managing director of B. and S. Massey, Ltd., Openshaw, Manchester, age 76.

OCEANIC AIR SERVICES

THE House of Lords has lately been the Chamber chosen by the Government for important announcements respecting the prospects of aviation in the post-war years. On a recent date (October 20th) the subject was raised by Lord Londonderry, and in the debate that followed a number of noble lords took part. The atmosphere of the Upper House is unlike that of the Commons; there is a simpler standard of speaking, and one senses even more clearly the machinery of government by the amateur so long dominant in this country and seen in that House at its most obvious, and no doubt at its best. To illustrate the simplicity of the atmosphere, we may cite Lord Beaverbrook's enthusiastic description of another peer as a leading technical authority in aeronautics, a description to which its surprised recipient would no doubt be the first to demur. But during the discussion very good horse-sense was shown. Lord Beaverbrook, for instance, was frank enough to assess the number of air liners which this country would be likely to operate after the war as no more than 2000, corresponding to a yearly constructional output of some 400; as many as a single one of the older established aeronautical firms could build in a few months. He did not make any estimate of the number of private aircraft likely to be built at the same time, but even if the aggregate tonnage of the two types were equal, which is to put the private output rather high, the industrial resources required for both would still be very modest. What additional numbers might be needed for military or police purposes is hard to forecast, since much depends on the nature of the peace settlement, when it comes, and on any special responsibilities we are expected to shoulder.

Much attention was given during the debate to the views expressed by the President of the United States, who considered he was also stating the opinion of our own Prime Minister, on the vital question of the freedom of the air. His statement has been generally accepted as fair and reasonable, and it remains to ascertain how to give effect to it. A reasonable interpretation would seem to be that all countries must provide and control their own internal services, whilst recognised services from other countries would have the right to land for refuelling or for taking aboard or disembarking international passengers. It was also implied that services which could run themselves from the financial point of view should, in general, do so, though Government support might be needed for those which could not, and were, for one reason or another, of essential importance. It is well known that the great shipping lines throughout the world are expecting to take a leading part in trans-oceanic air services, and their desire to do so will surely be intensified by the recent Press forecast by Pan-American Airways that the air journey from New York to London and back will take 27½ hours, and cost no more than £46 10s. So low a charge on so rapid and comfortable a journey would naturally have immediate reaction on the scale of passenger travel by sea after the war, and therefore on the nature and number of the ocean-going ships to be maintained. Since the day-to-day work of the shipping lines, as it existed before the war, as well as the scale of their revenues, would alike be gravely affected, it is but natural that those lines should seek powers to run oceanic air services, whether individually or in association. In fact, not to do so might be almost suicidal. Major Thornton, one of the directors of the Holt Line, has expounded in *The Times* and elsewhere how long experience in international sea communications could be applied to this new development. In his view, and it seems a reasonable argument, the creation of an international corporation to run the oceanic air lines would be profitless, since it would "merely make life more difficult than it is already," whilst national subsidies to international air lines should be abandoned, except where, for some good reason, public assistance has to be given for a specific route, in which case the cost should be shared between the Governments interested and the financial benefit divided appropriately between all the operators; further, that traffic competition on any route should be controlled by self-regulatory conferences, on the shipping model, having a potent voice in the fares to be charged, as well as in the *bona fides* of any new aspiring entrant to the route. Since such a scheme makes use of previous shipping experience, it is likely to prove acceptable to the shipping firms, and we do not see why it should not prove agreeable to Governments. The latter may in some cases have been working on other lines up to the present, but the position hereafter will be so different that they should be ready to think out matters afresh.

So far as Britain is concerned, one can safely say that a major interest of this country is the maintenance of an adequate Mercantile Marine, of which an important source of revenue may in future depend on passengers by air and go to those who can provide that means of transport. Hence it is surely reasonable that the right sort of shipping lines should be free to enter this field, and be welcomed by the Government if they wish to do so.

Oil Engine Outputs

THE "rating" of various types of oil engines has been given comparatively little publicity in the last three or four years, but behind the scenes it has been causing both heartburning and straight talking as regards war applications. Nor can the subject ever be far from the thoughts of builders and users in relation to post-war requirements. Particularly is this the case with comparatively quick-running marine engines, which, incidentally, in their "rating" characteristics are not greatly dissimilar from several classes of railway oil engines. There are users of both marine and traction oil engines who consider that their equipment should be "rated" at about 80 per cent. of the maker's figure. This value itself usually is only 75 to 80 per cent. of the maximum output possible of attainment on the test bed, so that the figure some users wish to be acknowledged is only 62 to 65 per cent. of the peak output. Indeed, figures suggested at one meeting of a technical institution a year or two ago meant the normal service use of only 48 to 50 per cent. of the maximum possible output. There is a growing tendency in marine circles to insist that the maker's "rating" shall always be the continuous one, which in marine work is likely to mean really "continuous," and not, as in railway work, perhaps three or four hours at a time.

There has never been any clarity as to just what produces the one-hour, ten-minute, and other "ratings" put forward by makers. Actually, they are governed by considerations such as piston ring sticking, injector fouling, bearing behaviour, and the like, none of which are basic factors, and all of which can be altered materially by merely detail changes in design, *e.g.*, the installation of tapered piston rings. Possibly the only fundamental factor is the maximum output which can be attained on the test bench, but

that is in no sense a "rating." Taken in the sense in which the word has come to be used in electrical engineering, the oil engine cannot have a "rating," because its constituents are not fundamentally affected by temperature rise in relation to time, as are, say, the windings of an electric motor. Subject to detail design, whatever temperature can be maintained for an hour can be maintained for several thousand hours until certain parts begin to fail through thermal or thermal and mechanical stress and fatigue. Once the maximum possible test bench output is known, each actual installation theoretically requires a different governed output to suit the particular working conditions. If a maker is going to list such things as ten-minute or one-hour "ratings," then he should do two things: First, provide means for keeping the load on only for that time; secondly, specify the loading conditions before and after the particular time limit. As far as we know the first condition has been met only once in the types of engine being considered especially in this article; the second has not yet been met. Moreover, a mere recognition of the continuous output as the standard figure is not enough. It might do very well in large marine and stationary engines, but for fast-running marine and transport engines there are many claims to recognise the one-hour output as the guaranteed basic service figure. Only on such runs as the "Flying Cologner," the Paris-Lyons trips, the "Denver Zephyr," "Super-Chief," and other American high-speed trains are the main engines run almost flat out for two to ten hours. The "Denver Zephyr," for example, has a load factor of 76 per cent. over the full sixteen-hour run from Chicago to Denver.

That some basic method of judging and correlating the performance of most types of oil engines must be evolved at an early date is becoming realised ever more strongly. It may be suggested that one of the first things to do to introduce and perpetuate basically correct values is to drop the word "rating."

Institution of Mechanical Engineers

AT an extra general meeting, held at the Institution of Mechanical Engineers on Friday, November 12th, 1943, a symposium of papers on reclamation of worn parts was read. The following discussion took place:—

Discussion

Mr. Gilbert Varley said that in the reclamation of cast iron parts he had used a method which consisted in preheating the castings and using a filler rod made from crucible-melted hematite iron, 3 per cent. silicon. He had been able to deposit up to as much as 3½in. in the finished machined state on machined tool parts with Brinell hardnesses up to 165. It was possible, of course, to use the normal electric welding methods, but in such cases machining would be found to be difficult. He had used the method of electro-deposition with great success for reclaiming worn dies for deep drawing, to such an extent that after depositing hard chromium on those dies he had been able to obtain a life from 3½ to 7 times greater than before. That seemed to be due to the fact that hard chromium was less liable to scoring than was the normal hardened steel surface. Such a deposited layer should not be too thick, and his general practice had been about 0·003in. after finish grinding. Too thick a layer tended to strip. Difficulty had been experienced on thin dies, which seemed to be brittle after plating, and the advice given by Mr. Hothersall with regard to low-temperature treatment would be tried out. It was obvious that that method of reclaiming dies by plating could be applied over and over again to the same die, and that had removed one of the serious bottlenecks from his own tool room.

He had had one experience, many years ago, of attempting to reclaim steel castings for the hubs of commercial vehicles by spraying them. The portion sprayed was a seat for a heavy ball race, and in practice the ball race fits worked loose. He would like to know whether Mr. Ballard had had any further experience of the use of spraying for force fits.

Mr. W. Savage said his company regularly used electric arc welding and electro-deposition, and with great success; but their experiments with metal spraying had not been very successful, and so far they had not used that method on production work. He had been very interested to hear what Mr. Varley had had to say about ball-bearing fits, because his company did try out metal spraying on housings in which they wanted to press ball bearings, and they tried to turn that sprayed metal out with a single-pointed tool. They might have gone all wrong—Mr. Ballard would probably deal with that matter later—but at any rate they were not successful.

They made the greatest use of welding, and on shafts (which in their class of work were highly stressed) a proper reheat treatment was always given after building up by welding. They used electro-deposition generally on work where it was required to put a few thousandths of an inch on a shaft to restore a press fit or to make the fit of a ball or roller bearing correct, and they had had very good success with that. One of the biggest drawbacks they had had with electro-deposition was the distance of the plant from their works; far too much time was used in the transport of parts to be salvaged. With electric welding they could do everything in their own works.

With regard to metal spraying, he must say that screw-cutting a highly stressed shaft to obtain a key for the sprayed metal filled him with horror.

Mr. N. H. Charles remarked that if he might suggest a broad, general rule, then he would say that, provided the heat did not result in excessive distortion or cause difficulty with heat treatment, welding would be his first choice. It brought the worn part back most nearly to its original condition, and restored the greater part of the strength which had been lost. Where welding did cause difficulty, electro-plating was often the solution. It was an ideal method for precision work on delicate parts, but plating became expensive where great thicknesses were required or where parts were large and difficult to handle in the bath. In such cases they turned to metal spraying, by which large areas and thicknesses could be built up at fairly low cost. The deposit had the disadvantages of low strength and poor adhesion, but the process was quite satisfactory provided that the working conditions were not too severe.

Colonel A. Levesley said that reclamation of worn parts was of importance to the Services, not necessarily as a financial saving, but more because of supply difficulties and the saving of time in putting equipments back into service when replace parts were not available where they were needed. Every part which could be reclaimed for further service also meant one part less to be replaced, and the sum of these resulted in a big saving of manufacture—labour, transport, and shipping.

Whilst the reclamation of worn parts by welding was not practised extensively in his own workshops, a certain amount of work was done daily in that direction as a matter of routine, and with excellent results. Furthermore, this technique was not confined solely to the ferrous group of metals. Such parts as selector forks were built up with aluminium bronze rod; stator ring teeth and gear wheel teeth with 3½ per cent. nickel rod; aluminium crank case bearings with 5 per cent. silicon rod; elektron crank cases with AZ 102 rod; and carburetters with zinc-base die-cast rod. In every instance oxy-acetylene was the welding medium. The repair of aluminium castings by the metallic arc process had not up to the present been entirely satisfactory, cracking in the transition zone, even after the adoption of preheating, being the most common fault.

Very little Stellite was used in his workshops, and what was used was deposited by the oxy-acetylene process. In view of the fact that commercial electrodes of this alloy were now available, it would be interesting to learn whether there was any technique peculiar to this process, remembering that Stellite attained its maximum hardness by slow cooling and that sudden quenching or cooling by air would lower its Brinell figure and lead to the formation of surface cracks.

Turning to the reclamation of worn parts by the metal spraying process, he suggested that the porosity of the coating might not always be beneficial, and in those instances where a metal-sprayed coating was applied for corrosion resistance as well as to resist wear, it would be interesting to know how it would compete against an electro-deposited coating of the same thickness and material.

Commenting on the properties of electro-deposited metals, it might be said that ordinarily chromium possessed almost no ductility, so that in thick coatings, for instance, 0·01in. thick, electro-deposits were brittle, and chipped and flaked if subjected to impact. On the other hand, much thinner coatings, for example, 0·00002in. thick, had been found to be comparatively ductile, and chromium nickel-plated sheet would withstand considerable drawing and forming. In view of the fact that there was an apparent increase in ductility with decrease in thickness of coatings, the suggestion had been made that chromium coatings, approximately 0·002in. thick, applied over electro-deposited nickel or directly over steel would be of value in the building up of worn roller paths. If there were any conclusive findings on that problem it would be useful to have them.

In that part of Mr. Hothersall's paper dealing with the effect of electro-deposited coatings on the mechanical properties of steel, it was mentioned that stressed electro-deposits reduced the fatigue strength of the parent metal. A question which suggested itself was whether or not a sprayed metal coating was of material advantage over an electro-deposited coating in preventing a

reduction of fatigue strength, particularly on parts already below plan size. Further, in connection with the stress developed in electro-deposited nickel coatings, it seemed logical to assume that softer deposits might be less stressed than the harder deposits. In view of that, therefore, and at the same time bearing in mind that nickel rapidly work-hardened, was not it more advantageous to electro-deposit working parts with soft nickel instead of hard nickel ?

Mr. Edward P. Paxman said that, in general, he would say that it was not practicable to build up worn crankshafts by welding unless subsequent heat treatment was possible. But if it was a question of reclaiming a shaft in which the machining had been carried too far, but at a stage which would permit of subsequent heat treatment, welding was practicable. They had recently tried the effect on diesel engine crankshafts of building up worn crank pins by spraying, and it seemed that considerable development of technique was necessary to ensure a satisfactory and lasting pin. The preparation of the pin in the first place must be under careful control, and he thought that there was evidence that the processes which had been developed in America were ahead of those in this country. The Americans used a fuse-bonding process, where an electrode was pressed against the material to be sprayed at a low voltage, and they got a first coating which was subsequently sprayed. The result of that was to put up the shear strength of the bond between two and three times. He would be most interested to have the author's views on that, and to know whether there would be any advantage in endeavouring to apply that technique.

Dr. E. C. Rolleson said there was a very big demand at the moment for the salvage of high-speed cutting tools which had been chipped or damaged by unskilled or "green" labour. Those cases could be classified into two main groups. In one, the tool was broken, but not the cutting edge, necessitating merely the joining of the two parts, and for that a hard surfacing electrode should not be used. A mild steel or stainless steel type of material should be used to join the two parts. On the other hand, for making the cutting edges of a broken or chipped tool there was usually considerable difficulty and trouble with cracking of the high-speed steel, even when it was preheated up to 400 deg. Cent. In that case his main recommendations were these. First, one should preheat up to 450 deg. Cent., which would make the trouble less severe, though it would not cure it. Secondly, one should use a smaller quantity of weld metal, spaced out intermittently to disperse the heat as far as possible.

Mr. J. Barrington Stiles remarked that in his introduction of his paper Mr. Ballard seemed to convey the impression, no doubt unintentionally, that he meant to cut out press fits and that class of work entirely from the metal spraying process. In fact, however, a great deal of good work was being done to build up ball-race housings and shafts to take ball-races in quite unlubricated positions. Another speaker had referred to troubles in that connection, probably when doing internal building-up work for the housings when the contraction forces were working against him; but, although he could not go into it that evening, there was a perfectly good technique for dealing with that. The fuse-bond process mentioned by Mr. Paxman was a comparatively recent development, a development of the metallic arc process applied to roughening the surface by using a special alloy which produced a foam, rather like the frozen froth of soap bubbles. The frothy surface provided an excellent bond for metal spraying. It was quite the latest technique, but it was intended only for certain special purposes, to provide for work which was too hard or not readily machinable by reason of shape or otherwise. Another American tool, the rotary shaft repairing tool, used a technique in which only round-bottom grooves were employed. They were small grooves, about 0·025in. wide and 0·025in. deep, the thickness varying from 0·025in. for cast iron to 0·015in. for other metals. Those ridges were pushed over by a tool similar to a five-bladed cutter with the five blades rigidly held together, and when one acted as a knurl the others tended to roughen the surface, and they pushed over the tops of those ridges to produce a suitable surface giving very great strength; the metal itself would fail first. Angular steel grit blasting was suitable for small work, though he would recommend an optimum pressure of 90 lb., and was the cheapest and easiest method, but unless sharp, clean grit was used and there was very scrupulous inspection it ought to be confined to work other than building up for engineering requirements, and he did not like it at all.

He thought that Mr. Ballard made a mistake, when pointing out the differences between American design and practice and those in this country, in emphasising that the American aim was speed. That was not so. It was true that they used larger wires than the only English gun manufacturers, but they also used smaller wires. They had that range of wires not only for convenience, but because when building up on large-diameter work they took the view that the wire should be increased as far as possible proportionately; much better deposits were obtainable by using a large wire.

Mr. H. Martin felt that a word of caution was necessary when discussing the deposition of hard-facing weld metal on to shafts in particular, which were subjected to fatigue. The very abrupt change of hardness between the deposit and the base metal could, he said, form a stress-raiser equally as dangerous as a notch, and for that reason the technique should be carefully gone into to make sure that everything was done to avoid sudden changes of hardness. He also thought that it was of some importance to confirm what others had said about the heat treatment of steel shafts after welding. Many of the shafts which came in for repair were supplied in the heat-treated condition, to get the best results from the material, and welding would naturally destroy the effects of that heat treatment. It was imperative, therefore, that those good qualities should be replaced by subsequent heat treatment. He had been very concerned when he read the suggestion in the paper that austenitic chrome-nickel weld metal might be used for the replacement of damage done by corrosion or erosion in boilers. He was not suggesting that it was not possible to do so with safety, but he thought that a considerable amount of thought and investigation should be devoted to the job first, particularly in those cases where there was any degree of alkalinity in the water, as electro-couples could easily be set up between the deposit and the base metal, and those who had had experience with locomotive boilers would know that the copper fire-box and steel shell could set up an electro-couple and galvanic action would result. He would anticipate that any alloy containing nickel in a water rich in lime or alkali would have similar results.

Dr. R. E. Wilson said that one claim which could be made for electro-deposition as compared with other processes was that it could be applied to interrupted surfaces—shafts with keyways, and so on, and on spline shafts, and very successfully to bores, whether the bores were continuous or with interrupted keyways in them. If there was a small error in any part, which was only a few thousandths of an inch out, one could put the deposit of nickel or chromium or whatever it might be straight on to the surface, without possibly weakening the article and, at all events, without doing any predeposition machining to it, and then do the machining. It did not matter if the deposit was so small that one could not set the job up sufficiently to ensure that one would still have some deposit left; in other words, if the surface ultimately presented was a mixture of the deposit and the parent metal it did not matter, because the bonding was so good that there were no feathery edges on it.

Some years ago he had wanted to determine the efficacy of nickel deposit in resisting corrosion and fatigue. The National Physical Laboratory tested for him specimens of commercial mild steel, some in the original state and others which had a deposit about 0·005in. thick of nickel. They were tested in a rotating beam fatigue machine with a fine spray of 3 per cent. common salt solution which was injected on the test portions of the specimens. The results showed that the untreated mild steel samples under test had an endurance limit of $\pm 7 \cdot 3$ tons per square inch, whereas the nickel specimens had an endurance of $\pm 12 \cdot 2$ tons per square inch. In other words, the endurance limit was increased by some 67 per cent., which indicated that there was a very material advantage in resistance to corrosion fatigue.

Mr. T. H. Turner remarked, in relation to railway work, that among his records he had a number of cases where an enterprising engineer had welded a tyre or an axle and a fatigue fracture had come about some years afterwards. Fatigue cracks following the welding of high-carbon steel were certainly to be dreaded. In the welding of rails electric welding gave a tremendous amount of trouble. That might have been expected, but he was speaking of a dozen years or so ago, when they were trying to find out what would happen. He had the most gruesome record of cracks with all types of electrodes at various current densities in trying to build up rails. The position was wholly different, however, with oxy-acetylene welding, and he thought that it was fair to say that every company in this country and many abroad were building up points, crossings, and switches regularly and were having no trouble, and, what was more, were building them up time and again, and as many as eight or nine times. It was a mistake to try to build up a tip $\frac{1}{4}$in.; it was better to keep building up about $\frac{1}{8}$in. The Iron and Steel Corrosion Committee, through Dr. U. R. Evans, of Cambridge, had carried out many tests in marine and industrial atmospheres which had proved the value of metal spraying as a corrosion preventative in competition with paints of all kinds time and again.

The authors of the papers made brief replies to the discussion.

L.P.T.B. Road Services.—Replanning of approximately 10,000 stopping places on 1586 miles of bus, trolleybus, and tram routes has recently been undertaken by the London Passenger Transport Board. Its object is to ensure a uniform scheme of stopping places in all districts. Where several routes stop at one post, they are being divided between two or more posts, if space allows, so that congestion of pavements may be reduced.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

HYDROGEN IN BOILERS

SIR,—I have read with interest the account by Engineer Vice-Admiral Sir George Preece and his experience with hydrogen from boilers.

Your correspondent, Mr. E. B. Parker, seems to have some doubt as to the possibility of this gas being generated in a boiler or, at any rate, in sufficient quantity to cause ignition when brought over with the steam and exhausted from the condenser by the air pump.

In his letter Mr. Parker seems to have in mind the working of land boilers, which present a very different picture to marine boilers working under sea-going conditions, as sea water, getting into the boiler with the feed, offers a problem which the engineer at sea is always being confronted with and with which the engineer in charge of land boilers is troubled very little or not at all.

There are definitely ways and means by which hydrogen can be generated in the boilers of a ship; for instance, the acidity of the boiler water due to the presence of sea water, and all acids contain this gas. The salts of sea water, especially the magnesic chloride, cause the water to act chemically on the exposed metallic surfaces. To arrest this corrosion zinc balls, or electrogens, are suspended in the boilers by iron baskets and by wire connected to them from such places as the furnaces and combustion chambers, so in this way the heating surfaces and internal shell of the boiler are made the negative electrode of a galvanic couple and by thus preventing any part from becoming positive corrosion is rendered impossible, whilst the hydrogen evolved from the negative surface (besides being the best preservative of iron) causes the scale to fall off before it can do any harm. Here, then, is one way in which hydrogen is generated inside the boilers, but it must be mentioned that the electrical current set up with the resultant liberation of hydrogen will only take place while the boiler water is of sufficient density to form a galvanic couple between the zinc and boiler shell.

Another method to prevent the formation of scale is on the same principle as stated above, except that it does not rely on the acidity of the boiler water before coming into operation. A dynamo is used to generate a low voltage, the negative wire of which is connected to the boiler shell and the positive wire to a soft iron bar (electrode) suspended between the tubes, but not in contact with them. When the dynamo is in operation an electrical circuit is set up through the electrode—positive element—and the boiler heating surfaces—negative element. The current so set up is of such intensity that hydrogen is set free underneath the scale and the scale, being impervious to the hydrogen, blisters off, leaving the heating surfaces clean, and, of course, allowing the fuel to do its full work, so again we see that hydrogen is generated by this means to a very considerable extent and is brought over with the steam through the engines and into the condenser, to be exhausted by the air pump into the atmosphere of the engine-room.

It seems highly probable that the boilers of the ship to which Sir George Preece refers were fitted with a system of this sort.

The ignition of the hydrogen by the sparking of the brushes of the fan motor is quite possible, even though the fan was running in such a way as to draw air down the vent, for it would depend on which way the vent was facing up on deck, for if facing away from a stiff head wind, a tendency to form a vacuum in the vent shaft would result, and the hot air of the engine-room would be drawn up with any hydrogen that was in the close vicinity of the vent, in spite of the effort of the fan to draw air downwards. Of the two opposing forces, the greater would prevail. The engine-room artificer who observed from the engine-room platform what he thought to be the fan motor sparking, shows at once that the fan was not directly inside the vent shaft, but at the mouth of it; otherwise he could not possibly see—from his position on the platform—any sparking of the brushes, and at that distance the burning of the hydrogen with a pale blue flame outside the commutator cage could easily be mistaken for the blue sparks or flashes from the brushes through the not always good lighting of the engine-room. How the explosion took place is perhaps a matter of opinion, and the vent no doubt had a considerable amount of influence over it, for we know the circumstances under which hydrogen will burn quietly or explode when a flame is brought in contact with it.

I do not think Sir George Preece intended that the incident in the engine-room should be in any way of a leg-pull or just a tale of the sea for the consumption of landlubbers. In engine-rooms on ships strange things do happen which call for investigation, and in the modern ship's engine-room the gradual outcome of numerous observations made by marine engineers of experience, and the majority of the improvements are due, not to the theorist who stays at home, but to the man who is brought immediately into contact with the practical element of the profession.

R. J. LINGLEY.

Beckenham, Kent,
November 13th.

INVENTION OR RESEARCH?

SIR,—About a decade ago the members of the Institution of Mechanical Engineers decided to try and find out how their industry could obtain the use of invention, and in this respect the circumstances then were very similar to those which affect this country as a whole to-day. In presenting his analysis of the position, Dr. Hatfield made the following statement, which presumably can be accepted, for it was not even discussed, let alone criticised:—

"The principal inventions upon which modern industrial development is founded were all made independently of scientific research. They were also made in the teeth of opposition by the trades and crafts which they affected."

Another authority, Admiral Fiske, LL.D., U.S.N., says:—

"These facts show that the work of the inventor is very different from that of the engineer, and the inventor and the engineer are very different people, though an inventor and an engineer sometimes live under the same skin. Only a small proportion of the engineers have made original inventions."

To a large extent the inventor may be compared to the composer of music, and the designer to the conductor of an orchestra. Engineering invention is work which calls for a special type of ability, training, and experience. The training should be both practical and theoretical, as in engineering; but at present both branches of this training have to be self-taught, generally a very slow process. There is an elementary though very useful form of invention, imagination controlled by knowledge and reason, which is easily learned, but this cannot be called real invention.

The following statements about research have been made by recognised authorities:—

"It is commonly supposed that modern technical invention is the child of scientific research, but that is certainly not the case" (H. S. Hatfield, Ph.D.).

"Whilst investigation and experimentation can hardly fail to secure data, they may secure nothing else, and usually do" (Fiske).

"Research then consists in weighing matter, measuring volumes, velocities, and so forth, which accompany the particular occurrence, and attempting to deduce a law" (Sir Dugald Clerk).

What Sir Dugald Clerk has said should surely carry weight with British engineers; his address on the subject to the Royal Society of Arts (1917) is a magnificent piece of work.

There is no doubt that it is desirable that data should be collected and formulæ produced in the way that research does, and that much more should be done; but it would probably be much cheaper in the long run, and undoubtedly far more productive, to have "existing" knowledge applied in a practical manner. That is the work of the inventor.

In order to be able to produce the goods which will sell abroad, and so enable each and every one of us to maintain his desired standard of living, the Parliamentary and Scientific Committee, Sir William Larke's Committee of the F.B.I., and Sir Harold Hartley ("Are You Research Minded?"), &c., are urging the manufacturers, the universities, and the Government to spend more and large sums on research. In view of the statements above, and many more like them, by authorities, is it not pertinent to suggest to these people that before their schemes can be considered with the necessary amount of seriousness and interest, it will be necessary for them to show how their proposed methods can be trusted to produce the desired new inventions and then bring them into use? By re-reading the letter of "One of the P.B.I." (December, 1942) it will be found that the methods which these people are pleading should be used do not even show how the new ideas which have been produced and worked out by competent men can be considered.

SYMINGTON MACDONALD.

Edinburgh, 2, November 10th.

BOOKS RECEIVED

Canteen Accounts. London: Industrial Welfare Society, 14, Hobart Place, S.W.1. Price 1s. net.

Electric Arc Welding Manual. Waltham Cross: Murex Welding Processes, Ltd., Hertford Road.

A National Transport Programme. Reprint. London: *Railway Gazette*, 33, Tothill Street, S.W.1. Price 1s. net.

Diesel Locomotives and Railcars in India. By P. R. Agarwal. Delhi: Manager of Publications, India. Price 9d. net.

Your London Has a Plan. London: Association of Building Technicians, 5, Ashley Place, S.W.1. Price 6d. net.

Design of Fans. By F. H. Slade. London: Prince's Press, Ltd., 7, Prince's Street, Westminster, S.W.1. Price 5s. net.

Manual of Firemanship, Part Three. London: H.M. Stationery Office, York House, Kingsway, W.C.2. Price 2s. 6d. net.

Aircraft Electrical Engineering. By F. G. Spreadbury. London: Sir Isaac Pitman and Sons, Ltd., 39, Parker Street, Kingsway, W.C.2. Price 21s. net.

An Introduction to Concrete Work. By H. L. Childe. London: Concrete Publications, Ltd., 14, Dartmouth Street, Westminster, S.W.1. Price 1s. 6d. net.

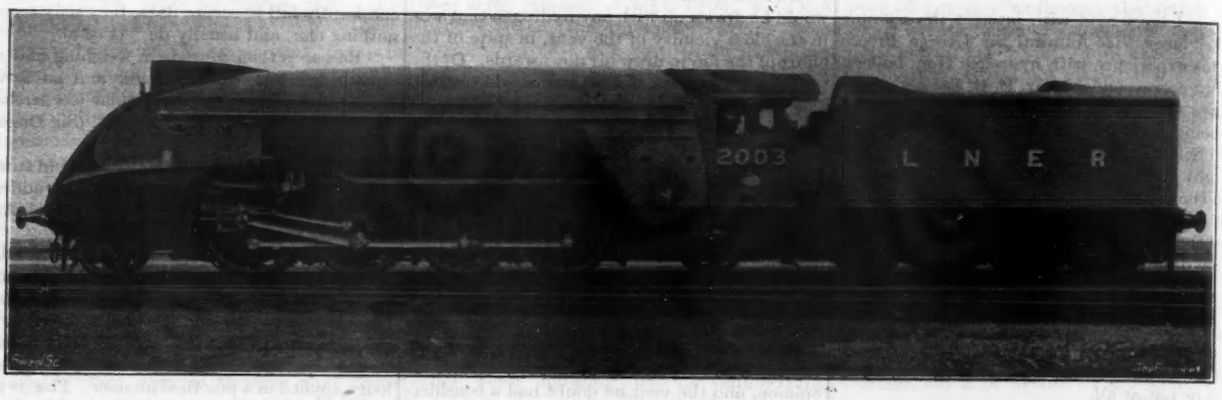
Thorpe's Dictionary of Applied Chemistry. Fourth edition, Vol. VI. By J. F. Thorpe and M. A. Whiteley. London: Longmans, Green and Co., Ltd., 43, Albert Drive, S.W.19. Price 80s. net.

L.N.E.R. Locomotive Conversion

To extend the range of operation of the 2–8–2 express passenger locomotives working in the Scottish area of the L.N.E.R., one of the engines, "No. 2005," originally built in 1936, has been reconstructed as a 4–6–2 "Pacific" type locomotive, thereby reducing the rigid wheel base from 19ft. 6in. to 13ft., and so giving much more freedom on the curves that abound on the L.N.E.R. Scottish lines. The new bogie, which takes the place of the existing pony truck and leading coupled wheels, has the horns, stays, and central control arrangements, all of welded construction. The bogie is of the side support pattern, taking the weight of the main frame through spherical surfaces on to bronze slippers. The centre line of these slippers is in direct line with the main bogie frame. The side control of the bogie is by means of helical springs, which give an initial control load of 2 tons, the maximum translation of the bogie being 4in. on either side of the engine centre line. The original engine already incorporated a spliced front end portion to the main frame, and the renewal of this front end only was necessary. The frame from immediately behind the original leading coupled wheels backward has been retained unaltered.

Although as many as possible of the original parts, including the outside coupling and connecting-rods and the outside motion details, have been used again, the conversion has included the elimination of the 2–1 lever gear and the substitution of a separate Walschaerts valve gear for operating valves on the inside cylinder. The new inside motion plate, which has thus been made necessary, and which also forms the main front end support for the boiler, is of welded construction, thereby eliminating the need for the provision of any new cast steel frame stays.

The main drive has been divided between the leading and second pair of coupled wheels. The outside cylinders drive on the second pair of coupled wheels and the inside cylinder on the leading pair of coupled wheels. The standard form of built-up crank axle, on which extensions to the webs form balanced weights, has been retained, and the new excentric, having a throw of 4¼in., is fitted on to the crank axle. The exhaust passage from the outside cylinders is taken outside the main frames to the inside cylinder casting, making a single blast pipe base in the smoke-box to take a double blast pipe and chimney similar to that fitted to the other 2–8–2 engines in service in Scotland. To straighten out the steam pipes, the boiler barrel was shortened somewhat and the length between the tube plates is now 17ft.



LOCOMOTIVE AS ORIGINALLY BUILT AND AS CONVERTED

Locomotives "No. 2005"

	As originally built as "2–8–2" type (Class "P2").	As rebuilt as "4–6–2" type (Class "A2").
Cylinders—		
Number	3	3
Diameter and stroke, inches	21 by 26	20 by 26
Boiler pressure, lb. per sq. inch	220	225
Heating surface—		
Fire-box, sq. feet	237	237
Tubes, sq. feet...	1,354·2	1,211·57
Flues, sq. feet	1,122·8	1,004·5
Total evaporative, sq. feet	2,714	2,453·07
Superheater, sq. feet ...	776·5	679·67
Total, sq. feet...	3,490·5	3,132·74
Tractive power, lb.	43,452	40,318
Adhesive factor	4·06	3·67

In comparison with the engine as originally built, the general proportions are as shown in the table.

The converted engine is at present doing good work in the Scottish area and her five sisters will eventually be similarly converted to the 4–6–2 wheel arrangement.

Utilisation of Waste Heat from Industrial Operations*

By W. H. DICKINSON, Eng. D.

PRIOR to the sixteenth or seventeenth centuries it does not seem to have occurred to anyone that waste or surplus heat, sensible or potential, from furnaces or ovens employed in industrial operations could be utilised, or else that it was even worth while to do so. Indeed, the scale of such operations, except perhaps in the case of a blast-furnace, was then so small that the idea, if mooted, must have fallen on sterile soil. Wood fuel was in use up till then, and there was no particular shortage, except near

* Newcomen Society, October 13th. Abstract.

cities, to suggest the importance of economy; the use of mineral fuel was still in its infancy. Whether any person did entertain the fecund idea prior to the dates given above we do not know.

Many methods whereby waste heat can be utilised, saved, or stored, or whereby heat may be conserved and thus the waste of it lessened, have suggested themselves from time to time, and the following classification of these methods has been adopted as fairly covering the whole field :—

(1) The simplest method, the one that was earliest exploited, and the one that has had a very wide application, is that of using the sensible heat, not only in furnace gases before discharging them into the atmosphere, but also that in the masonry in which the operation is carried out; this we shall term the convection method.

(2) There is then in chronological order the use of waste heat to warm a secondary gas or fluid that acts as a means of transfer of heat from one point to another; this we shall call the transfer method.

(3) A very important method is that by which heat is alternately stored and given back to the furnace; this is known as the regenerator method.

(4) Analogous to the preceding is the method of storing the heat of steam to damp out fluctuations in demand; this is known as the thermal storage or steam accumulator system.

(5) There is yet the method whereby heat units in waste gases still unconsumed are fired; this we shall call the burning method.

(6) Lastly, there is the case of the heat of hot bodies being distributed evenly between them—the soaking method.

Combinations of these methods, especially of (3) and (5), have been made with much success.

There are other sources of waste heat that may be mentioned, only to be dismissed as being outside the scope of this paper. One is the heat of the interior of the earth, coming to the surface in the shape of hot springs and utilised domestically or industrially as hot water. Many examples could be given, but one will serve, *i.e.*, the "bore" at Winton, Queensland, Australia: "A white column shot up a dozen feet, hissing and boiling. As the water fell it was trapped into a system of pipes . . . before being pumped to Winton (where it is laid on to the houses in the town). The overflow filled the gutter which steamed. Alongside squatted a row of swagmen, cooking eggs, stewing meat, boiling tea."[1] Another source of heat is marsh gas or methane, generated in the modern anærobic method of sewage disposal, collected, and either burnt in boilers for steam raising or compressed and used as fuel in motor vehicles—a striking example of a self-supporting cycle of operations.

(1) *Convection Method.*—The first practical exemplification of this method that we have come across was in the evaporation of salt solutions. In the preparation of copperas (sulphate of iron used in dyeing and in ink making), the liquor that seeped out of iron pyrites, oxidising slowly by long exposure to the weather in open heaps, was evaporated in shallow leaden pans. The waste heat from the pans was used to heat to the boiling point the solution before charging it into the evaporating pan. The process is thus described[2] in an "Account of the Way of Making English Green Copperas," communicated to the Royal Society by Daniel Colwall :—

> "The fewel for boyling is New Castle Coals. . . . But now of late by the ingenuous contrivance of Sir *Nicolas Crisp*, the work is much facilitated for at his Work at *Debtford*, they boyl off three Boylers of ordinary Liquor in one Week—which is done, first by ordering the Furnace so, as that the heat is conveyed to all parts of the bottom and sides of the Furnace. Then whereas they were wont to pump cold Liquor into the Boyler to supply the waste in Boyling, whereby the Boyler was checked sometimes ten hours; Sir *Nicolas* hath now a vessel of Lead, which he calls a Heater, placed at the end of the Boyler, and a little higher, supported by Barrs of Iron as before, and fill'd with Liquor, which by a conveyance of heat from the Furnance is kept near boyling hot: and so continually supplys the waste of the Boyler without hindring the boyling."

The inventor, or possible *entrepreneur*, Sir Nicholas Crisp, Bart., was a well-known Royalist. As he died in 1666, the date of his invention must have been some years prior to that; it was not patented. This mode of evaporation was extensively adopted for common salt and may even have been in use prior to Crisp's invention, but if so, we have not confirmed it.

This idea of using waste heat in the evaporation of liquids has been served up continually ever since, and, with variations, has been the subject-matter of many patents. No considerable development has taken place, and, indeed, there does not appear to be scope for such.

New possibilities commenced with the introduction by Newcomen of the atmospheric engine in 1712. It consumed large quantities of fuel, and consequently it was rarely to be found outside colliery districts, where coal was cheap, yet almost everyone who observed the engine at work must have been struck by the rush of almost boiling water from the eduction pipe into the hot well, and someone must have sought some way of saving at least a part of the heat. As early as 1725 water from the hot well, as well as hot water running over from the top of the piston, was used to feed the boiler, but whose idea it was we do not know; perhaps it was due to Henry Beighton. Watt, in his condensing engine, retained the practice of feeding the boiler with water coming from the hot well, and this has continued to the present day.

When Trevithick introduced his high-pressure engine in 1802 he was immediately conscious of the fact that, in dispensing with the condenser he was losing the heat previously conserved thereby, and sought to remedy this defect as early as 1803 by abstracting some of the heat from his exhaust steam. This he effected by surrounding part of the exhaust pipe by another pipe concentrically and passing the boiler feed water contraflowwise through the annular space. This has proved to be a fecund invention.[3]

Usually superior efficiency is attained by subdividing the exhaust, *e.g.*, by leading it through and over tubes—U-shaped, coiled helically, indented, or corrugated, of each of which examples are to be found, as also combined with means for keeping the surfaces clean, since a subsidiary purpose of these heaters is to keep back the mud in the feed water that otherwise would reach the boiler and result in incrustation on the shell. In all these heaters the principle of contraflow will be found.

As the boiler pressures and temperatures increased, the loss of heat in the waste gases became more noticeable, and this has led to a succession of inventions of feed-water heaters (so-called "economisers"), steam superheaters, and air preheaters. The economiser that is perhaps best known and whose merits have enabled it to persist to the present day is that originally patented by Edward Green (1799–1865) in 1845 (December 10th, No. 10,986), and subsequently improved by him and others. This apparatus, built into an enlarged part of the flue from the boiler to the chimney, so that it can, if desired, be by-passed by suitable doors or dampers, consists of a number of sections or stacks of vertical pipes forced into top and bottom headers, provided at the top with covers for cleaning and at the bottom with blow-off cocks for the removal of mud deposited from the feed water. The sections are in parallel and the feed water is pumped through them. The soot that would otherwise stick to the outside of the pipes, and eventually act as a perfect non-conductor of heat, is removed by embracing scrapers, caused to work continuously but slowly, up and down. These scrapers are in sections balanced by chains over pulleys and actuated by worm gear, reversed by a tappet-moved, three-bevel wheel clutch, overset by a rolling weight. It is this effective method of cleaning off the soot that has been the secret of the success of the apparatus.[4] A great amount of attention has been devoted to its improvement. In the first half-century of existence of the apparatus, it was supplied by Messrs. Green to over 150,000 boilers, equal to 30,000,000 I.H.P.

Besides their use for feed heating, waste gases from boilers can be used for superheating the steam evolved. In the case of tank boilers the apparatus consists of U tubes dependent in the flue at the point where the gases leave the boiler. In the water-tube boiler the superheater consists of tubes situated immediately beyond the combustion chamber. It does not therefore fall strictly within our purview, as the heat it utilises is not waste. This, again, applies to air preheaters in series with feed-water heaters.

A saving of sensible heat, although of minor amount, can be effected by tapping the heat of the masonry of the furnace in which industrial operations are carried on. This can be done by warming the air for combustion by leading it through flues or passages in the masonry setting before admitting it to the fire. This idea has occurred to many minds. The first application seems to have been to steam boiler settings for the prevention of black smoke. About 1810 John Wakefield of Manchester warmed air from the ashpit by passing it through flues and delivering it at or beyond the firebridge to complete combustion. A saving of 20 per cent. in fuel was claimed for this plan (*cf.* Patent Specification 1820, June 6th, No. 4472).[5] The plan has been tried repeatedly, but difficulties in cleaning out the flues and unintelligent manipulation by the low-paid labour which in the past has been considered all that was necessary for tending boilers, has militated against success.

The idea has been pushed in other directions. It is recorded that in 1836 at Rive de Gier, département de la Loire, France, the air supplying a beehive coke oven was heated by passing through flues in the brickwork. In the oven of the same type patented by John Robert Breckon[6] and Robert Dixon (1858, March 29th, No. 659, and 1859, December 12th, No. 2814) waste heat was passed through flues below the sole of the oven. This oven was much used in County Durham in the decade 1860–70, and many firms adopted it.[7]

In the modern retort oven where radiation losses would otherwise be excessive, owing to the speed of operation, extensive use is made of the method of preheating the air for combustion, not only by circulation round the base of the retort, but also through the vertical side walls constituting the retort itself. An advantage of this is that more of the oven gases can be spared for steam raising, &c., than otherwise, resulting in a better overall thermal balance sheet.

(2) *Transfer Method.*—An escape of heat that must have early suggested utilisation is that from reverberatory or other furnaces used in metallurgical operations. An early practical exemplification of this saving was made in 1762 by Sampson Swaine, an ironmaster of Neath Abbey, South Wales, but then residing at Carn Brea, Cornwall, who took out a patent (May 21st, 1762, No. 774) for using the heat from such furnaces for raising steam. In his specification he says :—

> "The furnace is either simple or divided into two, three or more parts, so that tin, copper or other ores, metals, or menerals, in their several states may be smelted and refined at the same time, without mixing, and at the same fire, or any other operation performed for which a large fire should be wanted. The boiler of the fire engine surrounds the furnace in such manner that the water contained therein will have the furnice in the middle of it, and receive heat from its top, bottom, and part of its sides and ends and also from the flew of the chimney. If more heat should be wanting, another furnice may be placed under the boiler."

The description is not so clear as we should have liked, or as it would have been if a drawing had been enrolled. Fortunately, however, Gabriel Jars (1732–69), the French metallurgist, during his travels in this country, 1765–66, saw and described one of Swaine's

plants at work at Wheal Chance, near Camborne. There was[8] a similar plant at Wheal Kitty. This is what Jars saw (translation) :—

"In an emplacement excavated below the level of the ground, 22ft. to 24ft. long and 14ft. to 15ft. wide, and underneath the boiler, which has the same dimensions, are constructed two reverberatory furnaces, in one of which the mineral is roasted and in the other is smelted; above these there is a third [furnace] of the whole length of the said boiler, the arch of which is made of bricks of a single thickness. But since the bottom of the boiler does not form the same curve as the said arch, there is necessarily a void between them. In the angles of the furnaces there are small boilers which by their correspondence that they have with the large one constitutes a single one only; independent of these three furnaces there is another smaller one, placed at one of the angles, but outside the boiler, which three tubes of sheet iron, about 1ft. in diameter, traverse the whole length; each of these tubes receives the gases and the flame which proceed from each furnace of cast iron, and which transmit it to three chimneys placed at the other extremity. As to those gases which come from the roasting furnaces, they are conducted the length of one side of the boiler which forms four different fires; a fifth which heats the other side is to be counted."

Jars says that the construction had made much noise in England, and, in his opinion, more than it deserved. He admits that the intention was good, but that Swaine's arrangement was bad, and showed that the latter did not understand metallurgy! On the one hand, a steam engine requires a steady head of steam, while, on the other, the requirements of a furnace fluctuate. Again, the furnaces could not be repaired without stopping the boiler, and *vice versâ*. Jars makes one favourable and acute comment :—

"What I find best in this construction are the tubes which pass through the water in the boiler."

Indeed, this is one of the earliest, if not the earliest, instance of employment of an internal boiler fire tube. Swaine thought a good deal of his idea, and in 1775 applied to Parliament for an extension of his patent, but without success.

Here, perhaps, may be mentioned a proposal that could be classified as "convection" and that is to take the steam obtained in evaporating a solution and utilise it, *e.g.*, in a steam engine. The first proposal of this kind that we have traced is that of John Stewart in 1767 to take the steam evolved in the evaporation of cane sugar juice for use to drive the steam engine.[9] No practical implementation of this idea seems to have resulted then or since. The solids inevitably carried over with the steam must have precluded its success.

REFERENCES

[1] Wood, Thomas—Cobbett, 1934, page 236.
[2] *Phil. Trans.*, XII, 1678, page 1058.
[3] Science Museum Catalogue, "Stationary Engines," 1925, page 46.
[4] An account in great detail of this invention is given in "Development of Green's Economiser," by W. H. Fowler, 1895.
[5] Much attention was given to the question of smoke prevention in 1819 by a Committee of the House of Commons. A review of the subject was given in Clark, D. K., "Steam Engine," 1890, Vol. I, page 151.
[6] Beck, L., "Geschichte des Eisens," IV, 479.
[7] Steavenson, A. L., "Trans.," N. of E. Min. Eng., 1872–3, XXII, page 3.
[8] "Voyages Métallurgiques," Vol. III, 1781, pages 219–232.
[9] "Trans.," XXI, 13.

(To be continued)

SOUTH AMERICAN IRON, STEEL, AND LEAD.—It is reported that Peru is to have an iron and steel industry with an annual production capacity of some 100,000 metric tons of finished iron and steel products. It is estimated that plant construction will take two or three years. Lead-mining operations are being encouraged in Southern Bolivia, particularly in the Sud Chichas Province. The Tito Hoyo mine has been re-established after being idle since 1931, and output has increased at La Aviadora, La Salvadora, and La Ripida mines.

Reclamation of Worn Parts*

BUILDING-UP AND HARD SURFACING BY WELDING

By WILLIAM ANDREWS, B.Met.†

Range of Operations.—The building-up or surfacing operations in which welding is employed may be considered as serving three main ends :—

(*a*) Repair or reduction of abrasion in all its various forms.

(*b*) Repair or reduction of corrosion of all types.

(*c*) Reclamation of faulty material arising from poor workmanship or other reasons.

The simplest material to deal with, of course, is ordinary carbon steel, which, as far as bulk is concerned, still forms the greatest single item in engineering fabrication. The contrast between the character of the two welding processes here becomes evident. Where it is required to build up, on a heavy base, a large mass of metal, of which the chemical composition is not of paramount importance, metallic arc welding is most suitable. If it is necessary that the weld metal should have as nearly as possible the same composition and response to heat treatment as the parent metal, the oxy-acetylene process has the advantage.

Effect of Arc Conditions.—The foregoing rough division of functions arises from the fact that control of weld metal composition, in the metallic arc process, is to some extent uncertain. The degree of superheat to which the weld metal is subjected depends principally upon the gauge of the core wire, and the thickness of the flux coating of the electrode used, and is largely outside the control of the welding operator. In order to understand the effect of arc conditions on the weld metal, some discussion of the process is desirable.

The temperature of the arc is so high that reactions between the various constituents take place with great rapidity. Whatever the type of flux coating used on an electrode, the presence of the atmosphere ensures that conditions tend to be oxidising (it is also known, of course, that reactions with nitrogen are favoured, but oxygen is the more active influence).

Metals Available for Arc Welding.—The behaviour of the elements most commonly used in steel making, when applied in metallic arc welding fluxes, is consequently variable. Nickel, copper, cobalt, molybdenum, and tungsten are under most conditions practically completely recovered in the deposit. Chromium, manganese, columbium, and tantalum are partially oxidised into the welding slag, to a degree depending upon the acidity or otherwise of the flux. About 70 to 90 per cent. recovery in the weld metal is obtained in these cases. Loss of carbon in the arc, whether originally present in the core wire or in the flux coating in some form, is very variable, and is greater the larger the diameter of the electrode used; but it is practicable to obtain weld deposits of high carbon content if required. Of the remaining elements generally used in ferrous alloys, vanadium is only occasionally used in significant quantities, but appears to be easily recoverable, though no data are available as to the percentage loss in slag. Titanium, uranium, and zirconium oxidise with such rapidity at arc temperatures that it proves impracticable, with present-day electrodes, to obtain weld deposits containing significant percentages of any of these elements.

It is frequently claimed with respect to silicon that certain electrode fluxes are fully reducing in character, and that chemical analysis shows the presence of silicon in solid solution in the weld metal. While this may be the case, it should be remembered that, by most of the usual analytical methods, the silica from the non-metallic impurities is reported as part of the silicon content, and, until this is clearly accounted for, analytically, and the consequent "killed" condition of the weld metal clearly demonstrated, such statements should be accepted with reserve. Aluminium is the in same class as titanium, and it is doubtful if statements that weld metal has been treated with this element, in order to secure its deposition in the fully deoxidised condition, have any real factual basis. Apart therefore from the possible effect on the ultimate quality of the weld metal of any of the deoxidising elements, the useful alloying elements available for producing alloy steel deposits by the metallic arc process are restricted, in practice, to nickel, cobalt, copper, chromium, tungsten, molybdenum, and columbium (tantalum is very similar in effect, but less widely available and less used). Vanadium may also be used, but is more often substituted by molybdenum.

There is thus no technical difficulty in duplicating most chemical compositions used in modern steel, except as regards high residual percentages of the more powerful deoxidisers and except also the uncertainty as to whether the weld metal is fully killed steel. The main limitation arises in the behaviour of the steel as a result of the rapid cooling, inseparable from metallic arc deposits. Weld metal containing hardening alloys, together with much above 0·15 per cent. carbon, hardens so intensively on cooling that, under the high and suddenly applied stresses inevitable with such a form of heating, it is almost impossible to avoid cracking of the weld metal, or the junction of the weld metal and parent metal, except in deposits of small volume. This condition is only partially mitigated by preheating and post-heating of the parent metal, and this often calls for a degree of handling of the work concerned which it is desired to avoid.

Special-Purpose Electrodes.—In view of the greater suitability of the metallic arc process for the deposition of relatively large masses, these factors have led to the development of a large range of commercial electrodes intended to provide weld metal of varying degrees of hardness for any required service. The number of these special-purpose electrodes is very large, and they are extensively advertised under a variety of trade names. It is to be deplored that information as to their chemical composition and other characteristics is almost entirely lacking in the trade literature, and little appears to have been published elsewhere. They may be roughly classified into the following two divisions :—

(1) Weld deposits of approximately 200–600 Brinell hardness value.

(2) Special deposits of an indeterminate but higher degree of hardness.

The process of reinforcement by welding, therefore, as far as a large section of the commercial application of the process is concerned, consists of depositing weld metal of relatively simple composition but capable of a wide variation in actual hardness, which depends partly on the carbon and alloy contents of the weld metal, partly on the conditions of deposition (size of electrode, mass of parent metal, &c.) and partly on the modification of composition, induced by interfusion with the parent metal. It is thus essential that the particular type of electrode to be used should be considered in relation to all these factors and to the ultimate service which the repair of reinforcement is required to withstand.

Quite obviously, a large variety of electrodes is justifiable, and probably essential, especially when the diverse parent metals which may be encountered are taken into account. The relatively simple make-up of this class of electrode suggests, however, that information as to the chemical composition of its weld metal, together with accurate data on the degree of hardening to be expected under controlled conditions on parent metal or various compositions, is an essential requirement to the standardisation of this branch of welding which, it is hoped, will be undertaken as a future item of research.

This first class of electrode includes both pearlitic and martensitic alloys, the limitations in the various types being controlled by the experience of the manufacturer or user as required by the particular work in hand. The second class of electrode, giving deposits of very high hardness and special properties, is

* Institution of Mechanical Engineers, November 12th. Abstracts from a symposium of three papers.
† Advisory Service on Welding, Ministry of Supply.

mainly directed to the deposition of weld metal having the properties of cutting tools and similar materials, and considerable success has been obtained in this direction.

The satisfactory use of such compositions, in which a rather wider range of alloys may be used than in class (1), depends upon the deposition of comparatively small pads or buttons of weld metal in such a manner that the weld is kept molten sufficiently long for the high alloy content of the flux coating to be evenly dispersed through the weld metal. Another governing factor is porosity—arising mainly from the partial oxidation of the extra carbon which this type of weld metal necessarily contains—which requires that the weld metal shall be molten long enough to allow time for the gas content to boil out. Instructions for the operation of this class of electrode usually describe the method of welding as being a puddling action, which perhaps is self-explanatory. It is usually claimed that, by correct welding procedure, a sound weld deposit, of satisfactory final hardness, can be obtained, requiring only final grinding. Howat,‡ in a valuable paper on the use of one of this class of electrode for depositing cutting edges on tools, shows that greatly superior results are obtained if heat treatment is properly carried out after the weld has been made, and that it is really wasteful to attempt to combine deposition and hardening, if full value is to be obtained from the expensive alloys used.

Oxy-Acetylene Welding.—The oxy-acetylene process overlaps the metallic arc process to some extent in all these applications, and competes favourably with it in certain cases. The great value of the process, as far as steel is concerned, lies in the facility with which the higher-alloy steels of the nickel, nickel-chromium-molybdenum, and similar types may be reinforced with material of the same composition where it is desirable that, by heat treatment after welding, the structure of weld and the heat-affected zone shall be equal to that of the unwelded material. This requirement is of frequent occurrence in work where the mass of the parent metal is small, as in the reclamation of worn parts in internal combustion engines, gears, camshafts, connecting-rods, &c., and oxy-acetylene welding finds a very wide field in this direction. The process does not normally compete with arc welding as a means of fabricating cutting tools by direct deposition, particularly those of the high-speed class.

Welding of Non-Ferrous Metals.—Less has been done in the direction of applying welding to non-ferrous metals than to steels; but some interesting examples of the flexibility of the process may be cited. Aluminium castings, for example, are frequently repaired by both gas and arc processes, and in both cases the adaptability of the 5 per cent. silicon alloy as weld metal is surprisingly widespread. It is now quite common to use metallic arc electrodes, having a core wire of this composition, for welding alloys as different as "L 5" (12·5–14·5 per cent. zinc) and "L 33" (10 per cent. silicon).

Of the copper-base alloys, both bronze and brass are frequently reclaimed by welding. With the oxy-acetylene welding process zinc-bearing alloys, such as brass, are readily handled by maintaining an oxidising flame which prevents zinc volatilisation by the formation of a skin of zinc oxide over the molten metal. It is impracticable, however, to use zinc-bearing alloys as core wires in metallic arc electrodes. The operation of the metallic arc process on brasses, with its attendant advantages where heavy masses of metal are to be dealt with, is made practicable by the fact that, with a bronze electrode having the correct make-up, a satisfactory junction can be made between the tin-bearing weld metal and the zinc-bearing parent metal. This fact is made use of in the building-up of cavitation erosion in ship propeller blades.

Welding of Special Alloys.—In conclusion, it is interesting to refer to the special alloys which rely upon the hard carbides, borides, &c., of the heavier metals for their unique properties. Here, to date, the oxy-acetylene process holds the lead, as its special properties would lead one to expect. With the castable alloys, such as Stellite, metallic arc welding is perfectly practicable, and has been developed to the point where commercial electrodes are now available.

Extreme hardness, demanding the application of the maximum quantity of the hard compound, as in the case of oil well drills, for example, has not yet proved to be attainable by the metallic arc process, and the flexibility of the acetylene process allows the control of the application of these very refractory materials to a much more fusible parent metal, in a manner to which the direct metallic arc is much less suited.

Considerable progress is now being made, however, with the development of the tubular welding rod, consisting of a metal tube rolled from strip and acting as a container for carbide and boride hard metal particles, as a metallic arc electrode.

‡ Howat, D. D., 1942, South Wales Inst. Eng., paper presented at meeting on September 10th, "The Application of Weld Deposited Cutting Edges on Tools" (not published).

THE METAL-SPRAYING PROCESS

By W. E. Ballard, A.I. Mech. E.§

(*a*) Is Metal Spraying a Suitable Method of Reclamation?

The deposit of metal obtained by spraying has a peculiar structure. Each particle, as it reaches the surface to be treated, flattens out, and the final deposit is therefore a conglomerate of small bodies which resembles the result of piling large numbers of saucers indiscriminately together, with all but a few lying horizontally. The edges of the particles are irregular and it is the interlinking of these irregularities which binds the units together in the mass. This structure can, of course, be modified by subsequent treatment, but that will largely militate against the advantages of the method, and is therefore not usual. The piled structure must be taken into account in practice, and it will be seen that in such a conglomerate, the strength will differ slightly when considered in relation to the applied force, but in any event it will not be high. Untreated deposits obtained by spraying are not in themselves strong enough to add strength to a reclaimed part, and therefore in specifying metal spraying the engineer has to satisfy himself that the worn part is in itself strong enough for further duty. If this is not so some other method must be used.

It will be seen, moreover, that the structure of sprayed metal will cause it to be very weak if the thickness is reduced to too great an extent. The finishing coating should be at least 0·015in. thick. This may necessitate the further reduction in size of the part to be treated, and therefore the strength of the part must be considered, not as it is when taken from service, but when it is ready to receive the deposit.

The bearing surface of a shaft represents the ideal job for reclamation by spraying, and it is of no importance whether the working speed is low or high. During the short time which elapses while each layer of the coating is built up, a certain amount of contraction occurs, and this serves to tighten the metal on to the shaft. If the surface to be built up is flat, this contraction still operates, and unless precautions are taken, it will tend to loosen the deposit at the edges. When building-up an internal bore the contraction tends to draw the deposit away from the shell, so a special technique is required. The process of spraying need not cause any large increase of temperature; loss of temper of the part is therefore avoided, and the areas of weakness which usually surround welds do not exist. Owing to the nature of the structure, the deposit is not usually regarded as ideal under conditions of impact, and it is not possible to build new splines on shafts. Generally, if both the bearing surfaces of a shaft and of the bearings are worn, it is preferable to build up the shaft and to leave the internal diameter of the bearing oversize, rather than to build up both the bearing and the shaft.

Returning to the simile of the pile of saucers, it can be visualised that however closely the units lie together, there will be spaces between some of them, and that these spaces will be in part interconnected. This is true also of sprayed metal, especially in deposits of metals, such as steel, with high melting point. Measurements of porosity have been made by many investigators (Rollason, 1937), but published results may often be misleading, because the porosity depends on the closeness of the piling, and this is, in turn, dependent on actual spraying conditions. Nevertheless, some porosity is always present in sprayed coatings of metals of high melting point. Shaw (1937) shows that this porosity allows the deposit to become impregnated with oil, and also produces a surface containing minute pores which exude oil in service. This results in a perfect retention of the oil film on lubricated surfaces, and reduces wear to a minimum. Under partially lubricated conditions the advantage is more marked, as breakdown of the oil film is long delayed.

§ Director, Metallisation, Ltd., Dudley.

(*b*) How Must the Work be Prepared for Spraying?

There is always a temptation on viewing a worn part to consider only the more obvious portions of the damage and gauge all the work to be done from this inspection, but in the case of a shaft the worn portion may be reduced by, say, 0·040in. on the diameter at the point of maximum wear, the diameter gradually increasing on either side of this point until the unworn portion is reached. If this be so, the shaft must be turned or ground 0·030in. under the original diameter throughout the whole length of the part to be reclaimed. If this is not done, the deposit thickness will decrease until it amounts to only a few thousandths of an inch. A weakness must develop in such circumstances, and will result in the breaking away of flakes.

If the reduction is made some way along a shaft, it is sometimes advisable to undercut slightly the vertical face at the limits. This procedure is quite sound, as it allows the sprayed metal to be dovetailed into the base; but if this method is used, it is necessary first to fill the undercut by direct spraying. If this is not done and the spraying is allowed to follow the normal layer-on-layer principle along the length of the repair, the undercut is likely to collect the very fine metal dust generated from the first passes. This dust may subsequently be covered with metal, and in service such a metallic crust will break away. Although it has been suggested (Reid, 1941) that this is due to excessive carburisation of the metal at this point, the trouble is found to be entirely mechanical.

Having prepared the part for deposition as far as size is concerned, the next point is a consideration of the surface for receiving the sprayed metal. There is no "line-up" between sprayed deposits and the base metal, and adherence can only be obtained by the application of the particles in the spray to a suitably roughened surface, the surface itself also being free from grease. The right surface is usually obtained by shot-blasting with angular steel grit. The pressure of the blast and the size of the abrasive to some extent depend on the hardness of the surface to be treated, air pressures of 30 lb. to 60 lb. per square inch being normal, whilst the grit should pass a sieve having from fifteen to thirty meshes per inch.

Another method of surface preparation in common use to-day has the advantage that it can be carried out in a machine shop without additional plant. It consists merely in roughening the surface by means of a screw thread of from twenty to thirty threads per inch and about 0·03in. deep. The thread is cut as roughly as possible, so that the apex of each thread is torn.

(*c*) What Method of Spraying and Which Metal Should be Used?

All reclamation work using such metals as steel and nickel is achieved with the gas-fed pistol, using the metal in wire form. Tools using electric heat, generated as an arc, are often described in the technical Press, but as yet there seems to be no indication that the gas pistol is likely to have serious competition, because it is easily controlled and gives a uniform deposit of known properties. Moreover, it produces these deposits with reasonable

speed and economy. The wire piston has four feeds:—

(1) The metallic wire.
(2) A combustible gas under pressure.
(3) Oxygen from cylinders.
(4) The compressed air blast.

It is obvious that some alteration of the type of coating produced may result from a variation in the feed of the air or the gases, or in the rate of presentation of the metallic wire. To these variables may be added at least two others, namely, the distance of the tool from the job and the movement of the tool in relation to the surface of the work. A fair amount of technical work has been done in Germany (Thormann, 1933) on the relations of these variables and their effects on the coatings and has been followed by certain investigations in this country (Ballard and Harris, 1936). Briefly, it has been found that increasing nozzle distance increases porosity and oxygen content, and a large consumption of the gases increases oxidation. Although, for a skilled operator working in laboratory conditions, it is easy to alter the type of coating to suit the job, it would be too much to expect the ordinary operator to do this, and in these circumstances makers of metal-spraying tools as a rule design their equipment to strike a general satisfactory value, and each tool will give a good average performance if used as recommended by the suppliers.

There is, however, a very sharp difference between English and American practice in this direction. The average English metal-spraying pistol is designed to use wire 1½ mm. or 2 mm. in diameter, and with steel to give a deposit of about 5 lb. per hour. The average American pistol always uses wire upwards of 2 mm. in diameter, and deposition rate is at least twice that suggested by English practice. It is therefore desirable to examine this difference critically. It has been proved that there appears to be an optimum point at which the amount of oxygen in the coating and the amount of porosity imparted are in "equilibrium." If conditions are varied to give a different coating, the percentage porosity may diminish as oxygen content increases, and *vice versâ*, but this point of balance will be slightly different for coatings of a coarse texture from that for coatings of a fine texture.

English practice has aimed at producing coatings with the finest possible texture at the greatest possible speed, and at designing tools which will, in the hands of an ordinary operator, give a coating with a mean value of oxygen content and porosity. It has been found that this can only be achieved with a medium rate of deposition. American practice has developed along rather different lines in that endeavours have been made to produce metal-spraying pistols which will deposit a maximum amount of metal in the smallest interval of time. To do this it is necessary to add more heat to the melting flame, which can only be done by increasing the volume of the flame and the amount of gas fed to it. To accommodate the volume of the flame it is necessary to open out the annular ports carrying the propellant blast of compressed air which surrounds the flame, and as a result the angle of the pistol nozzle becomes less sharp. To get a fine spray under these conditions it is found better to use more air at slightly higher pressure.

Unfortunately, it has not been found possible to produce, by the high-speed pistol, the type of structure aimed at in England. In this country it is felt that it is better to err on the side of slow deposition and to get a technically balanced coating, and it will be of interest to note whether, in process of time, any commercial failures will be ascribed to too high a rate of deposition.

(*d*) What Finish is Necessary?

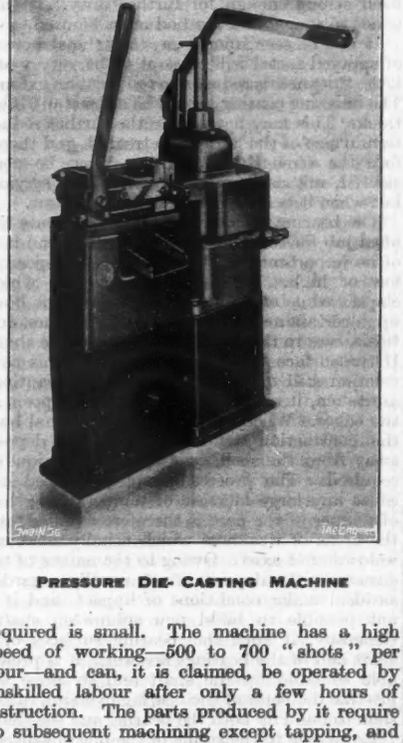
The normal finish of metal as sprayed is matt. With a pistol correctly adjusted the matt surface has a rather satin-like appearance, and should not be definitely rough. Nevertheless, it would be impossible, when building up by metal spraying, to ensure that the final surface, as sprayed, would be within reasonable limits of tolerance in regard to dimensions. It is therefore usual to build up the sprayed coating so that it is a few thousandths of an inch greater than the desired dimension, and then to reduce to size, usually by grinding. If high-carbon steel has been used as a deposit and the spray has been at all chilled, it will be too hard to be treated by any type of cutting tool. The grinding of metal-sprayed coatings does not really call for any special comment, except that the most satisfactory stone appears to be medium bauxite with a vitreous bond, using suds as lubricant. The speed should be 5500ft. per minute, and the pressure on the stone should not be great.

It is often suggested that the sprayed deposit should be case-hardened or heat-treated in some way. Such treatment is unnecessary, and may lead to serious failures. It has been proved (Rollason, 1937) that at the temperature at which recrystallisation of the metal can take place, the normal expansion of metals with increasing temperature gives place to a rapid contraction in the case of the sprayed metal. For instance, sprayed copper commences to contract rapidly at 600 deg. Cent. (1112 deg. Fah.), because the reorientation of the crystals tends to fill the porosities in the deposit, with a subsequent decrease in volume. This is disastrous if the coating completely encircles a shaft, as fracture must obviously occur. Therefore, if very hard deposits are necessary, high-carbon steel should be sprayed and the surface kept chilled. Chromium wire is not available, so chromium coatings cannot be deposited by wire spraying.

(To be continued)

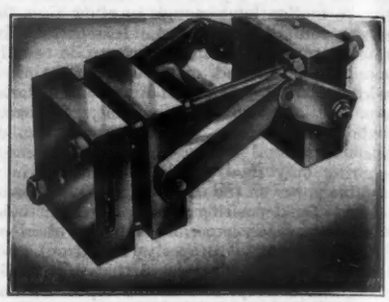
Pressure Die-Casting Machine

The machine illustrated herewith has been designed by Die Casting Machine Tools, Ltd., 122, Green Lanes, London, N.13, with the object of placing at the disposal of manufacturers a complete die-casting unit, whereby components in zinc, tin, or lead-base alloys can be produced economically, even although the quantity required is small. The machine has a high speed of working—500 to 700 "shots" per hour—and can, it is claimed, be operated by unskilled labour after only a few hours of instruction. The parts produced by it require no subsequent machining except tapping, and a general tolerance of plus or minus two-thousandths of an inch can be maintained on their dimensions.



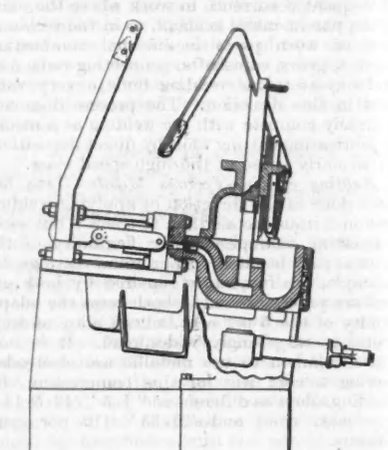
Pressure Die-Casting Machine

The caster consists of a pot unit and a die unit mounted together on a cast frame and base. The pot unit comprises a melting pot of heat-resisting iron and having a goose-neck cast integrally with it; a plunger operating in a honed bore at the end of the goose-neck; a hood aligned over the bore; and a system of levers for operating the plunger. The plunger is mounted collinearly with a shank working within a bore in the hood and connected to the plunger handle by a release pin. Links connect the handle to a bracket on top of the pot casting and to a return spring. A nozzle of patented design is fitted to the goose-neck. It is so constructed that the solidified portion of the metal in the nozzle is withdrawn on the "sprue" of the casting, thereby avoiding the freezing of the nozzle. The melting pot is heated by an atmospheric burner using town's gas at a rate of about 120 cubic feet per hour. The pot is lagged with silicon wool.



Die Unit

The die unit consists of two steel die plates, one of which is fixed against the nozzle while the other can slide on a pair of rods extending from the fixed plate to a block mounted on the base of the machine. The moving die is operated by means of toggle links coupled to a lever handle. The fixed die plate is water cooled to protect it from the heat transmitted from the pot. Ejector pins are arranged in the die. On the opening stroke of the toggle links these pins eject the casting from the die and cause it to be delivered on to a chute on the side of the base frame.



Arrangement of Die-Casting Machine

The required shapes can be cut either in the die plates themselves or in steel pads fitted to them. If desired, automatic or hand-operated side cores can be fitted to work in conjunction with the die plates. The pot has a capacity of 70 lb. of zinc. The castings produced on the machine may have a weight up to 5 oz. each.

G.W.R. "Specials."—Since the beginning of the war 55,000 special trains have been run by the Great Western Railway for Government personnel and stores.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

Iron and Steel in the United States

In the United States production of iron and steel is being maintained practically at capacity. Recently the steel output was said to be averaging in all districts 100·8 per cent. of the estimated capacity, the weekly output being placed at 1,756,900 ingot tons. This compared with a steel production of 1,748,000 tons a month ago. A record for any thirty-day month is claimed by the Republic Steel Company, with a production of 723,980 ingot tons in September. The company also claims a record output in the same month of 115,000 tons at its Cleveland strip mill. This mill was visited by British steel trade representatives shortly before the war, before it had been adapted to rolling ship plates. At Pittsburgh the steel works operations are reported to be near 103 per cent. of capacity, whilst at Chicago a rate of 99·5 per cent. is claimed, at Buffalo 90·5 per cent., and Cleveland 96 per cent. The volume of new business reaching the works is maintained at a high figure. The sheet and plate mills in several instances are already fully booked until mid-summer of next year. The shipments of finished materials into warehouse under the Controlled Material Plan are moving at a satisfactory rate. Two steamers for ore shipment have been completed and commissioned. It is intended to operate them during the fourth quarter to help in building stocks of ore to carry the pig iron industry through the first quarter of next year without diminishing output. The ore situation has improved somewhat, but there is room for further improvement. The production of pig iron is at capacity. At Pittsburgh only one furnace is reported to be idle for repairs and forty-five to be in operation. Three new furnaces in this district are approaching completion. In the Youngstown district the full number of twenty-six furnaces is operating at capacity. The Republic Steel Company has almost completed a new furnace at Cleveland.

The Pig Iron Market

Although there has been an undoubted improvement in the position of refined and low and medium-phosphorus iron, and consumers are obtaining more adequate supplies, the production has not been increased to the extent expected. The imports of ore from North Africa have been moderate, and a considerably larger quantity could be used. The position of hematite has not been affected to any considerable degree, and the production, although larger than it was a few weeks ago, is still below consumers' requirements, and the Control has to exercise great care in the distribution. Careful economy has to be practised in the use of this pig iron, and licences are only issued in cases in which no other description of pig iron will serve for the purposes required. The demand for hematite iron has not declined to the extent noticeable in the case of some other descriptions of pig iron, and the whole of the production passes rapidly into consumption. The engineering foundries are taking up good quantities of low and medium-phosphorus pig iron, as well as those foundries producing special castings. The effects of the war are to be seen in most departments of the iron and steel industry, and one of the most noticeable changes that have occurred has been the practical cessation of the manufacture of foundry pig iron on the North-East Coast. Consumers there are being supplied by Midland blast-furnaces, and are receiving all the iron they require, whilst the official maximum price they have to pay includes all rail charges, so that they are not suffering any financial disadvantages. High-phosphorus pig iron is in ample supply, and consumers of this grade are able to obtain liberal supplies. The light castings industry is operating at well below capacity, although it is handling a bigger volume of business than for some time. Probably it is the largest user of high-phosphorus pig iron, but the demand is not sufficient to absorb the whole output. Recently some of the light foundries have benefited to some extent from the seasonal trade in heating appliances. The raw material position of the pig iron industry is good, and supplies of native iron ore and coke are plentiful. Stocks of coke are substantial.

Scotland and the North

Although there have been some difficulties owing to transport troubles, the production of iron and steel at the Scottish works has been maintained at a high level. It is not surprising that some troubles have arisen on the railways, as ever since the war began the rolling stock has been subjected to extreme wear and tear, and the work thrown on the railway repair shops has been of an arduous nature. The difficulties arising from occasional insufficiency of wagons, due to necessary overhauls, has been quickly dealt with and overcome. Fears that these troubles might react adversely upon production have proved groundless, and the activity of the works has been fully maintained. The pressure for delivery so far during the current delivery period has been as heavy as at any time this year, and the works have been stretched to the utmost to maintain a steady and regular flow of deliveries. The production of plates has been increased somewhat recently, but, even so, the demand is sufficient to take care of the whole output in this country, and there have been times when it seemed as though the huge requirements of the shipyards would outpace the productive capacity of the mills. The demand for structural steel is on a heavy scale and the producing works have a big volume of orders in hand. Medium and light angles and tees are chiefly in request, and there is a comparatively moderate demand for the heavier joists and sections. The re-rolling industry in Scotland has been operating at capacity for some time, and is heavily committed for deliveries during the current period. For new business the majority of works are only able to promise delivery in Period I of next year. Good supplies of billets, blooms, and sheet bars are reaching the works, and many of the re-rollers have been able to build up useful stocks. There is an active demand for sheets, but most of the works are committed for some months ahead, and are reluctant to accept new orders. The shipyards are taking big quantities of sheets whilst Service demands are also on a heavy scale. Marine engineers and power plant producers are fully employed, and are taking up big quantities of steel. Lancashire consumers of iron and steel are heavily committed, and are absorbing large tonnages. The demand for bars, large and small, has strengthened somewhat during the past week or two, and small bars in particular have been in request. The engineering industry also is a big consumer of large-diameter bars, and some of the producing works have indicated recently somewhat extended delivery dates. The volume of business in reinforced concrete bars has declined during recent weeks, but there is still a fairly active request. Busy conditions rule at the steel works on the North-West Coast, and great efforts have to be made to maintain deliveries. Production, however, has been maintained at a high rate, and is likely to remain so, since the raw materials position is satisfactory.

The North-East Coast and Yorkshire

In spite of some changes in production which have taken place during the past few weeks, as a result of readjustments of the Government's war production programme, the output of the steel works on the North-East Coast on an ingot basis is as large as at any time this year. There seems little prospect of any relief to the producing works during the remainder of the year from the insistent pressure for delivery, and there is no doubt that the demand for steel materials will be just as heavy in the first period of 1944. The output of semis is on a heavy scale, and deliveries to the re-rolling works are maintained with regularity. At the same time the re-rollers are making good use of defectives and crops and other material which can be used for their purpose. There has been no slackening in the strong request for plates of all descriptions. This has been the principal characteristic of the demand for steel for many months, and so far as can be seen is likely to continue for the duration of the war. The sheet makers are contributing considerable assistance to meet this demand by producing large quantities of light plates from their mills. There is an important volume of business passing in sections, although the demand is confined largely to the lighter descriptions. There has been no noticeable improvement, however, in the demand for heavier joists and sections, and most of the works producing these descriptions would be glad to receive more orders. The engineering industry is responsible for a heavy request for steel bars, and there is a tendency for the delivery dates for some of the larger steel bars to lengthen. The re-rolling works also are carrying heavy orders for small steel bars and strip, but there is only a moderate demand for reinforcing bars. Colliery requirements are heavy, although many of the collieries have already covered their allocations for the present delivery period. There is, however, a persistent call for roofing bars, props, arches, and rails. Conditions in the Yorkshire steel industry have remained practically unchanged for the past six months. There is a steady call for basic steel, and the plants producing this material are working to capacity. Fortunately, there is no shortage of raw materials. There is an active business passing in acid carbon steel and the works order books are sufficiently heavy to keep them busy for the remainder of the year. Recently there has been an increased demand for the more expensive descriptions of alloy steel, although the activity in this section is not so great as last year.

The Midlands and South Wales

The general position of the iron and steel industry in the Midlands has not altered for some time. The principal development in the situation has been the slackening in demand which commenced some weeks ago in the volume of new business. This is due partly to changes in the Government war production programme, which have resulted in the requirements of certain descriptions of steel becoming less urgent, while, at the same time, increasing the strength of the demand for others. Mainly, however, the apparently easier conditions are due to the iron and steel works having booked up their production for the remainder of this year and well into the first period of 1944. Attention now is largely turned upon the new allocations which will be issued at the end of December, and there is little doubt that the pressure of demand which will make itself felt then will be as strong as in the last period of the current year. The production of plates, heavy as it is, is barely sufficient to meet the intensive demand. The plate mills are congested with specifications for plates of all descriptions, but the principal consumers are the shipyards, although wagon builders, locomotive builders, and engineers employed upon armaments work are big users. The structural steel position is gradually strengthening. There is still only a moderate business passing in heavy joists and consumers have little difficulty in covering their requirements. A heavy demand persists, however, for light structural sections and small bars, and the re-rolling works are operating at capacity, principally on urgent business. Most of the re-rollers have programmes which extend well into next year. Consumers are obtaining good supplies of semis, principally of British manufacture, and withdrawals from stocks of imported material are comparatively light. The iron and steel industry in South Wales is fully employed. A satisfactory feature of the position is the big production of semis, and considerable quantities are passing from Wales to other parts of the country. Business in structural material is active, although the demand is principally for the lighter sections. A considerable volume of business is offering to the sheet mills, but few of them are in a position to give delivery before the early part of next year, and this is having a restrictive effect upon the amount actually placed. The tinplate industry is quiet, largely as a result of the regulations which have been imposed upon the industry.

Iron and Steel Scrap

The demand for scrap in most districts is active, and it is still principally for the better grades of heavy scrap. The lighter descriptions of scrap are meeting with a stronger request than for some time, but, even so, the demand leaves something to be desired. Heavy steel scrap and basic steel scrap are readily taken up when parcels become available. The demand for the latter has become stronger of late, as consumers have been drawing upon their stocks and are anxious to replenish them. Little demolition scrap has been available for some time, as most of it has been distributed to consumers, and few parcels of fresh material are coming forward. There is a good volume of business in heavy turnings, and bundled steel scrap and compressed shearings are meeting with a more satisfactory demand than of late. A plentiful supply of mild steel turnings is arising, and there does not seem much difficulty in disposing of the good heavy and chipped grades, but the other sorts are not readily taken up. An active business is passing in mixed wrought iron and steel scrap for basic steel furnaces, and substantial quantities of good heavy material have changed hands. Light material is in good supply, and consumers are showing more interest in this material. Stocks also appear to be accumulating at some consuming works. Cast iron borings are meeting with a steady demand. Generally speaking, supplies of cast iron scrap are not plentiful, and there is a noticeable scarcity of machinery metal. There have been a fair number of offers of mixed descriptions of cast iron scrap which are being taken on steady lines. There is a heavy production of cast iron borings and the blast-furnaces have been taking up satisfactory deliveries for some time. Cast iron scrap in large pieces and furnace sizes is actively sought by consumers, who do not find it easy to cover their full requirements.

Notes and Memoranda

Air and Water

H.M. Cruiser "Gambia."—H.M.S. "Gambia," a "Crown Colonies" class cruiser, has been lent to the Royal New Zealand Navy. For the present she will be under the operational control of the Admiralty.

The Air Liner York.—The latest British 36-seater air liner, the York, has recently completed the return trip of her maiden flight to England from Montreal in 10 h. 25 min.—an average speed of 213 m.p.h.

U.S. Destroyer "Beatty."—A United States Navy Department communique reports that the destroyer "Beatty" has been sunk in the Mediterranean. The "Beatty" was a "Bristol" class destroyer of 1700 tons displacement.

Timber for Aircraft.—The Indian Forest Research Institute has been investigating the likelihood of India providing timber for aircraft. The Indian Forest Leaflet No. 29 deals with the selection and field testing of aircraft quality spruce and fir, before the extraction of timber. Carefully selected Himalayan spruce, for example, seems to possess generally better bending and compression qualities than the Sitka spruce, but does not stand shock so well as the latter. It has been found in most cases that if a specimen passes the brittleness test, it invariably passes all the remaining tests. The brittleness test therefore is the acid test, and should be performed in the field. The leaflet illustrates a suitable machine for carrying out this test, which is easily portable, and can be fitted up anywhere. The observations can accurately be read directly from a dial.

Miscellanea

Canadian Gypsum.—It is estimated that the production of gypsum in Canada during 1942 amounted to 566,166 short tons, as compared with 1,593,406 short tons produced in 1941. The drop in tonnage, it is explained, was caused chiefly by heavy demands made on shipping on the Atlantic coast.

Wholesale Prices of Fuel Oil.—We have been asked by the Petroleum Board to publish the following official list of wholesale prices of burning and vaporising oil. Wholesale prices per gallon:—Pool burning oil: England and Wales and South mainland of Scotland (*a*) 1s., (*b*) 1s. 0½d.; pool vaporising oil: England and Wales and South mainland of Scotland (*a*) 1s. 0½d., (*b*) 1s. 1d.; pool burning oil: North mainland of Scotland (*a*) 1s. 1d., (*b*) 1s. 1½d.; pool vaporising oil: North mainland of Scotland (*a*) 1s. 1½d., (*b*) 1s. 2d.; pool burning oil: Northern Ireland (*a*) 1s. 0½d., (*b*) 1s. 1½d.; pool vaporising oil: Northern Ireland (*a*) 1s. 1d., (*b*) 1s. 1½d. (*a*) In bulk through hose in minimum 200-gallon lots. (*b*) In bulk ex road tank wagon in minimum 20-gallon lots.

New Helium Plant.—In recognition of the co-operation of the Navajo Indians of Northern New Mexico and Arizona, the new helium extraction plant being built by the United States Bureau of Mines on the Navajo Reservation in New Mexico has been named the Navajo Helium Plant. The Bureau of Mines is the sole agency entrusted with the production of helium for Government use, and it has authority to sell the gas for medical, scientific, and commercial use, to acquire gas lands, drill wells, construct pipe lines, and carry on other necessary operations. The Bureau's helium plants are now producing approximately twenty-five times as much of the gas as in pre-war days. The Bureau is meeting the requirements of the Armed Forces for anti-submarine "blimps," barrage balloons, meteorological balloons, and other uses. In addition, considerable quantities of helium are employed for medical purposes, in diving and caisson work, and in welding magnesium aeroplane parts.

Kenya as a Source of Minerals.—The war is providing Kenya with opportunities for developing some of its mineral resources. A company has been formed to begin the more intensive development of the mica deposits in the Sultan Hamud area. Mica deposits are found in this region, both in the Masai and Machakos districts. It is anticipated that the cutting and grading of mica for the market will be undertaken. At Tsavo, about 130 miles from Mombasa, a concession has been given to another concern to investigate the possibilities of a low-grade deposit of graphite. If this turns out to be of a suitable quality for the crucible industry, it might come into competition with Ceylon and Madagascar, which have been the principal producers of this grade of graphite. A new asbestos area in West Suk is to be worked at a pilot plant now being erected at the workshops of Kavirondo Gold Mines, Ltd., which have ceased operating on the production of gold and turned over its workshop facilities to other wartime production.

Economy in the Use of Lubricating and Industrial Oils.—The Ministry of Fuel and Power has received many replies to the appeal that each factory should make one member of its staff responsible for economy and efficiency in the use of lubricating oils. It is clear that managements are endeavouring to economise in the use of this product, which has to be brought in tankers across the Atlantic, and which is vital for the offensive action of the Fighting Services. The task now is to intensify and sustain these efforts. It is hoped that every factory will now have appointed an officer, who, backed by the goodwill and determination of all concerned, will be able to reduce still further the lubricating oil consumption of his plant. The officer, the Ministry says, should inaugurate a plan of lubrication which will result in substantial economies without any diminution in lubricating or mechanical efficiency. A bulletin, the first of a series, giving general advice on how this object can be achieved, has been published by the Ministry. Details of savings which can be made with various types of lubricants will be given in later bulletins. The national drive for economy is being made with the co-operation of the lubricating oil pool and the distributors of lubricants and cutting oils. Assistance in formulating the plan of lubrication best suited to any particular works can be obtained on request from the works oil supplier.

Personal and Business

Sir George Thomson has been appointed Scientific Adviser to the Air Ministry.

Captain G. F. Davies, R.A., has been appointed a director of Hick, Hargreaves and Co., Ltd.

Mr. D. MacArthur has been elected a director of Metropolitan-Vickers Electrical Company, Ltd.

Mr. L. Southcott has been appointed manager of the Newcastle depôt of Marine Instruments, Ltd.

Mr. R. F. Legget, M.Eng., has been appointed Associate Professor of Civil Engineering at the University of Toronto.

The Council of British Manufacturers of Petroleum Equipment informs us that its address is now 40, Palace Chambers, Bridge Street, London, S.W.1.

Professor A. V. Hill, M.P., Secretary to the Royal Society, has been invited to visit India to advise on problems of scientific and industrial research in relation to reconstruction problems.

The Controller of Iron and Steel, Ministry of Supply, has accepted with regret the resignation of Mr. Enos Smith, Director for Wire Rods, Wire and Wire Products. Mr. A. Scott and Mr. N. Anderson have been appointed Directors.

The British Aluminium Company, Ltd., announces that from November 29th its temporary head office address will be Salisbury House, London Wall, London, E.C.2. From the same date the offices of the company at Shrewsbury, Shropshire, and at Marlborough Court, 68, Pall Mall, S.W.1, will be closed.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Fuel Luncheon Club

Wednesday, Nov. 24th.—Connaught Rooms, Great Queen Street, W.C.2. Luncheon Address by Sir William Fraser. 12.40 for 1.10 p.m.

Institute of Fuel

Thursday, Nov. 25th.—Engineers' Club, Albert Square, Manchester. "The Aims and Objects of the Institute in Relation to the National Fuel Position," E. W. Smith. 3 p.m.

Institute of Transport

Saturday, Nov. 20th.—Metropolitan Graduates: Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Railway Accounting and the Engineer's Department," J. A. R. Turner. 2.15 p.m.

Tuesday, Nov. 23rd.—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Post-War Inland Freight Transport," R. O. Squarey. 1.15 p.m.

Institution of Automobile Engineers

Thursday, Nov. 25th.—Coventry Graduates: Technical College, Coventry. "The Study of an Epicyclic Transmission," E. R. Dawtrey. 7 p.m.

Monday, Nov. 29th.—Derby Graduates: School of Arts, Green Lane, Derby. "Performance Characteristics of Steering Gears," H. N. Charles. 7 p.m.

Institution of Civil Engineers

Saturday, Nov. 27th.—N.W. Assoc.: Engineers' Club, Albert Square, Manchester. "Earth Pressures and Sheet Piling," S. Packshaw. 2.30 p.m.

Institution of Electrical Engineers

To-day, Nov. 19th.—Measurements Section: Savoy Place, Victoria Embankment, W.C.2. "Instrument Transformers," A. Hobson. 5.30 p.m.

Monday, Nov. 22nd.—Informal meeting. Savoy Place, Victoria Embankment, W.C.2. "The Administrative Structure of Electricity Undertakings," G. V. Harrap. 5.30 p.m.—N.E. Centre: Neville Hall, Westgate Road, Newcastle-upon-Tyne. "The Future of the Domestic Wiring Installation," W. J. H. Wood, F. Jackson, G. Smith, and E. Jacobi. 6.15 p.m.

Tuesday, Nov. 23rd.—N. Midland Centre: Great Northern Hotel, Leeds. "The Future of the Domestic Wiring Installation," W. J. H. Wood, F. Jackson, G. Smith, and E. Jacobi. 6 p.m.

Wednesday, Nov. 24th.—Wireless Section: Savoy Place, Victoria Embankment, W.C.2. "Enemy Airborne Radio Equipment," C. P. Edwards. 5.30 p.m.

Thursday, Nov. 25th.—Savoy Place, Victoria Embankment, W.C.2. Nikola Tesla Special Commemorative Meeting. Lecture by Dr. A. P. M. Fleming. 3 p.m.

Monday, Nov. 29th.—London Students: Savoy Place, Victoria Embankment, W.C.2. "Multi-Channel Voice-Frequency Telegraphs," P. J. McMahon. 7 p.m.—N.E. Centre: Neville Hall, Westgate Road, Newcastle-upon-Tyne. "The Economic Flux Density in Large Supply Transformers," D. J. Bolton. 6.15 p.m.

Institution of Factory Managers

Saturday, Nov. 20th.—S.E. Branch: Bonnington Hotel, Southampton Row, W.C.1. Inaugural meeting. 2.45 p.m.

Institution of Mechanical Engineers

To-day, Nov. 19th.—Storey's Gate, Westminster, S.W.1. Hawksley Lecture. "Gyroscopic Principles and Applications," C. E. Inglis. 5.30 p.m.

Saturday, Nov. 20th.—Southern Branch: Polygon Hotel, Southampton. "Remember the Past and Look to the Future," F. C. Lea. 2 p.m.—N.W. Graduates: Engineers' Club, Albert Square, Manchester. "Colliery Mechanical Engineering," F. E. Rainford. 2.30 p.m.

Friday, Nov. 26th.—Informal meeting. Storey's Gate, Westminster, S.W.1. "The Economic Use of Fuel in Works Boiler Operation," J. H. Beynon. 5.30 p.m.—Scottish Graduates: Royal Technical College, Glasgow. "Welding as Developed by the Mechanical Engineer," W. C. Brodie. 7.30 p.m.

Institution of Production Engineers

To-day, Nov. 19th.—N.E. Section: County Hotel, Newcastle-upon-Tyne. "Surface Finish and its Application to Practical Problems," G. Schlesinger. 6.15 p.m.

Saturday, Nov. 20th.—Preston Section: Atlas Ironworks Canteen, Blackburn. "Metallic Arc Welding from the Production Engineer's Viewpoint," W. J. Vernon. 2.30 p.m.—Nottingham Section: Victoria Station Hotel, Nottingham. "Cemented Carbide Cutting Tools," Mr. Pinder. 3 p.m.

Wednesday, Nov. 24th.—Leicester Section: College of Technology, The Newarks, Leicester. "Hydraulics Applied to Engineering Problems," H. C. Town. 7 p.m.

Iron and Steel Institute

Tuesday, Nov. 23rd.—Modern School, Cole Street, Scunthorpe. "Review of Basic Open-Hearth Practice at an Australian Plant," R. L. Knight. 7.30 p.m.

Junior Institution of Engineers

To-day, Nov. 19th.—39, Victoria Street, S.W.1. Informal meeting. 6.30 p.m.

Friday, Nov. 26th.—39, Victoria Street, S.W.1. "The Development of British Gun Ammunition Components," H. S. Rentell. 6.15 p.m.

Liverpool Engineering Society

Wednesday, Nov. 24th.—Municipal Annexe, Dale Street, Liverpool. "Stromberg Carburetter," C. H. Fisher. 6 p.m.

Manchester Association of Engineers

Saturday, Nov. 27th.—Engineers' Club, Albert Square, Manchester. "The Manufacture, Testing, and Protection of Steel Pipes for Water Mains and Services," J. H. Smith. 2.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Wednesday, Nov. 24th.—Student Section: Bolbec Hall, Newcastle-upon-Tyne. "Yacht Design," O. Clemmetsen. 6.45 p.m.

Friday, Nov. 26th.—Mining Institute, Newcastle-upon-Tyne. "Notes on the Design and Performance of Water-Tube Boilers for Cargo Steamers," W. Sampson. 6 p.m.

Royal Society of Arts

Monday, Nov. 22nd.—John Adam Street, Adelphi, W.C.2. "Forest Products," W. A. Robertson and H. A. Cox. 1.45 p.m.